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TRANSACTIONS

OF THE

SOCIETY

FOR THE ENCOURAGEMENT OF

ARTS, MANUFACTURES, AND COMMERCE.

His Royal Highness The Duke of Kent.

K. G. &c. &c.

Late a Member of the Society

for the Encouragement of Arts Manufactures & Commerce.

Engraved by Chas Warren from the original Picture by Sir William Beechey,
in the possession of his Royal Highness the Duke of Sussex.

TRANSACTIONS

OF THE

SOCIETY,

Instituted at London,

FOR THE

ENCOURAGEMENT

OF

ARTS, MANUFACTURES, AND COMMERCE;

WITH THE

PREMIUMS OFFERED IN THE YEAR 1820.

VOL. XXXVIII.

LONDON:

SOLD BY THE HOUSEKEEPER, AT THE SOCIETY'S HOUSE IN THE ADELPHI;

AND BY ALL BOOKSELLERS.

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PREFACE.

PREFACE.

IF the value of the communications made to a Society, be considered as a true index of the estimation in which it is held by the Public, the members of the Society of Arts, &c., have ample reason for satisfaction on reviewing the subjects rewarded during the last Session, and now forming the 38th Volume of their Transactions.

The Committee of Correspondence and Papers, under whose superintendance the communications composing the annual volume have been prepared for the press, and illustrated by explanatory engravings, have bestowed an unusual degree of time and attention on this most important duty. They have expedited, by every means in their power, the operations of the Draftsmen, the Engraver, and the Printer, being fully sensible how greatly the interests of the Society and of the several Candidates are benefitted by an early publication: they have the pleasure to find that their labours in this

respect have been successful, and trust that in future they will be attended by an equally satisfactory result.

In order that the Public and those of the members who have not had an opportunity of attending the meetings of the Committees and of the Society at large, may be enabled to form an adequate estimate of the value of the volume which is now presented to them, it may not be out of place to take a brief and general view of its contents.

In the class of Agriculture, the account of the Duke of Devonshire's extensive plantations in the ancient but wasted forest of Inglewood, demonstrates the attention that continues to be paid by the greatest landholders in the country to this interesting branch of rural economy. Mr. Young's letter shows the successful progress of the cultivation of opium in Britain; an object which, after many unsuccessful attempts, from following too closely the practice in India and in Turkey, seems now, by the perseverance and skill of the gentleman just named, to be completely attained.

In the class of Chemistry will be found Dr. Hibbert's interesting communication respecting his discovery of Chromate of Iron, in Shetland; a mineral to which the painter is indebted for his

most brilliant yellow pigment, and the enameller and porcelain manufacturer for their purest greens. This mineral, which has hitherto been found in a state of purity and abundance fit for the manufacturer, only in the territory of the United States of America, is now, by the happy application of mineralogical science on the part of Dr. Hibbert, demonstrated to exist in considerable abundance in our own country.

The Glaze for Porcelain communicated by Mr. Rose, of the Coalport China works, is another example of the successful practical application of our own mineral productions; and from its intrinsic merit in not debasing the tone of the most delicate colours, will contribute to the reputation of British porcelain, which is now beginning to enter into active competition with the finest fabrics of this ware in Europe.

In the class of Polite Arts will be found a very important communication from Messrs. Perkins, Fairman and Heath, on their method of perpetuating and multiplying to an almost indefinite extent, the finest productions of the engraver. This method well deserves encouragement, considered merely as a means of rendering cheaper, and therefore more generally accessible, those graphic illustrations by which the acquisition of many branches of knowledge is greatly facilitated. But it is entitled to put

forth a higher claim to the public estimation as the most probable mode by which the forgery of bank notes may be checked and perhaps prevented. The Society of Arts have already publicly evinced the interest which they take in the removal of this great opprobium on our age and nation; and if by continuing to call the attention of the public to the encouragement of those plans which appear the best calculated to prevent the perpetration of this crime, their efforts shall finally be crowned with success, no words will be able adequately to express their satisfaction.

The class of Mechanics contains, as usual, a greater number of communications than all the rest combined. Of these, Mr. Hardy's beautiful Escapement, the perfection of which has been demonstrated by ample trials, deserves perhaps the first place. In this construction friction is almost wholly done away with, a much less maintaining power is required, and the isochronism of the vibrations appears to be as perfect as the properties of matter itself will permit. Mr. Perkins's method of drawing off the Back Water from Water-Wheels, greatly increases the power of these machines, and enables the manufacturer to take full advantage of those periods when an abundant flow of water affords the means of performing the greatest quantity of work. The Ships' Pump of the same gentle-

man being capable of being made by any carpenter out of materials which are necessarily to be found on board every ship, offers an important and efficacious resource to the mariner in times of peculiar peril.

Mr. Hookey's improvements in the construction and adaptation of Ships' Rudders are calculated to prevent accidents from hawsers getting foul of them; they also increase the rate of sailing, by preventing the retardation occasioned by the rudder on the common construction, and at the same time give it better hold on the water, and consequently greater cómmand of the ship.

Captain Burton's Apparatus for applying the manual power of the crew to give a progressive motion through the water to Ships of War on a lee shore, or when becalmed under an enemy's batteries, has been proved, by experiment, on board His Majesty's ship Active, and on this account is now offered to the public.

The Bellows or Blowing Machine of Messrs. Jeffries and Halley needs only be seen to be approved. The small space which it occupies, the ease with which it is worked, the unintermitting and efficacious blast that it delivers, have, in the course of a few months, occasioned its adoption in so many public and private forges as completely to

justify the liberality of the Society towards its ingenious inventors.

Mr. Austen's method of adjusting and supporting the Bed-stone of a Corn Mill enables the miller to ensure the perfect parallelism of the stones, and by that means to increase both the quality and quantity of the flour.

Mr. Jopling's rules for the formation of Ribs for Groined Arches will, no doubt, be duly appreciated by the practical architect: a greater regularity and symmetry are obtained and at a less expense than in the ordinary mode of construction.

Mr. Holdsworth's Arched Timber Roofs exhibit a happy application of Mr. Hookey's method of bending Timber for Naval Uses to the purposes of domestic carpentry; a secure, roomy, and economical roof is thus obtained, and which, upon trial on a large scale, appears to accomplish every purpose aimed at by its inventor.

Mr. Cherry's Blocks and Auxiliary Springs for Carts and other Carriages adapt these machines for more extensive service; and at the same time that they diminish their wear and tear, prevent also the ruinous concussions to which articles of furniture and other perishable materials are liable when conveyed in carts of the ordinary construction.

Contrivances for the preservation of human life have always experienced a ready attention from the Society of Arts, and a liberal reward in proportion to their merit. From this feeling a substantial mark of approbation has been conferred on Mr. Trengrouse, for his method of effecting a communication between a stranded ship and the shore by means of a Rocket, and for the unwearied zeal with which he has endeavoured to get his plan introduced into practice. From a similar feeling, combined with approbation of the ingenuity and mechanical skill displayed by Mr. Elliott, in his Safe Coach, the Society have conferred on him their Gold Medal, the highest reward which any member can receive.

In the last Volume, under the class of Colonies and Trade will be found an interesting account of the successful endeavours of Mr. Denovan, of Leith, to cure Scotch Herrings according to the Dutch method. For this the Society conferred upon him a considerable pecuniary reward. A similar testimony of their approbation has since been bestowed on the same candidate for the introduction of Scotch Herrings into the Hamburgh market, cured under his directions and superintendance with so much skill as secured to them the first price at that celebrated mart. The possibility of entering into successful competition with the Dutch

fishermen at the chief market in Europe for this commodity having been thus demonstrated, the Society may with perfect confidence leave to the known skill and activity of our merchants and seamen the task of following up and securing an advantage, the road to which is now opened and pointed out to them.

The above are the principal, though by no means the whole contents of the Volume now offered to the Public. It has not been thought necessary in this rapid summary to particularize every communication, although the rewards bestowed, whether honorary or pecuniary, were not given without due deliberation, and a conviction that in so doing the Society were conscientiously assigning an adequate reward for the degree of merit displayed in each particular case. The only recompense that the Society looks to and can possibly receive, is that of being considered by their countrymen as having contributed as far as their limited means allow, first, to the welfare of that national community of which they are proud to bear the name, and ultimately to that of civilized society at large.

THE Society take the present opportunity of returning their Thanks to the different Public Bodies and Individuals who have honoured them with Presents during the Session, the particulars of which are noticed in the body of the Volume. Without presuming to direct in what channels the liberality of the friends to this Institution shall flow, it may be stated that such contributions as may put the Society in possession of a compleat collection of all the Publications of any value on the application of Mathematics to practical Mechanics, will be especially acceptable.

The Society desire it to be clearly understood, that as a Body, they are not responsible for any Opinion, or Representation of Facts, contained in the following Pages.

PAPERS

IN

AGRICULTURE.

N° I.

PLANTING FOREST TREES.

The GOLD MEDAL *of the Society, being the premium offered, was this Session awarded to his Grace the* DUKE *of* DEVONSHIRE, *for planting* 1,981,065 FOREST TREES. *The following communications on the subject have been received from Mr.* JOHN MACHELL, *Agent to his Grace.*

Low Plains, near Penrith,
February 1st, 1820.

SIR;

ON a division of the extensive wastes of Inglewood Forest, in the county of Cumberland, a few years ago, three allotments containing together upwards of 1,800 acres, were awarded to his Grace the Duke of Devonshire, who was Lord of the Forest, and had also a considerable claim upon it in right of his ancient estate within its limits. Two of these allotments, the situation and soil of which

offered a reasonable inducement for investing capital in their improvement, have been inclosed, sub-divided, and proper farm buildings erected upon them, and they have since been brought into a high state of cultivation. The third allotment called the High Stand, which was considerably more sterile, and afforded no such inducement, was annexed to one of the others, as an out pasture, for two years after inclosure; but finding that in this state it yielded only a low rate of interest upon the money expended in erecting its boundary walls, it became necessary to consider in what way it could be better employed, with a view to either immediate or prospective advantage. The profitable result of an attempt to bring it into cultivation was more than doubtful; and the well known benefits which have resulted from planting lands of this description, as shown by daily experience, and very ably pointed out in the ingenious and valuable communications made to the Society in the years 1808 and 1809, by one of its members (Mr. Waistell) have led to its appropriation to that purpose. His Grace was pleased to direct that the whole of this extensive tract of ground (with such reservation only as is more particularly described hereafter) should be planted with useful Forest Trees, in such proportions as were suitable to the nature of the ground; and that this object should be carried into effect during the winter of 1816, a season of unprecedented scarcity of employment for the labouring poor.

Accordingly, as a preliminary step to the planting, all the super-abundant water was taken off the boggy and wet lands by open drains, varying as was requisite from 2 to $3\frac{1}{2}$ feet in depth; and of these drains 7,958 statute rods were cut, at different prices, from 2*d.* to 6*d.* per rod, making a total expense of 109*l.* It was also found necessary to root up and burn the furze or whins with which the surface of the ground was in some parts covered, in order

to make room for the plants, and to obviate the danger of their being smothered in their early growth.

The soil consists of three distinct varieties. The first is a dry, sandy, deaf soil, varying from 6 to 8 inches in depth, with red freestones occasionally embedded in it, and upon a substratum of sand. The second is a wet soil of 7 or 8 inches deep, principally composed of fine sand, with a small admixture of clay, and upon a wet subsoil of sand and ferruginous clay. The 3rd and worst kind, is of a wet, peaty nature, black in colour, 4 or 5 inches in depth, with white stones upon its surface, and resting upon a coarse grey sand, under which is found a retentive stratum of sand and clay.

On the 29th of November 1816, the planting commenced, and the whole plot containing 550 acres, 1 rood, 6 poles, exclusive of fences and of the roads out set for carrying away the thinnings, was completed on the first day of April 1817.

The plants were set at the distance of 4 feet asunder, or 2,722 per acre, one-fourth part of which number, and these consequently standing 8 feet apart, consisted of hard wood, under which denomination are comprehended oak, ash, elm, beech, sycamore, alder, birch and poplar, the term being used by the planters of this part in contradistinction to the pinus class. The hard wood planted on the better soils had been generally 3 years transplanted, on the inferior 2 years; and being more uncertain in its growth, and having also larger roots than the larch, Scotch and spruce firs, which were only of 1 and 2 years transplanting, it was thought desirable to give them the advantage of pitting, or of having a sod cut to a proper depth and turned out some time previous to planting; the plant being afterwards placed in the centre of the pit, and the sod cut in two, the halves were returned to their proper situation on each side of the plant, and closely

pressed about it. The object of pitting was to obtain a better adjustment of the roots, and to afford the soil the benefit of exposure to atmospheric influence, so as to enable this description of wood to keep pace with its more hardy and quick growing competitors of the fir kind. With these latter, the shorter and more simple method was pursued, of making two cuts with the spade, in the form of the letter T, then raising the sod at the junction of the cuts, and pressing it down again after the plant was introduced. The larch and Scotch firs were distributed over the whole plantation, but proper circumspection was used in planting the different kinds of hard wood upon those soils best adapted to their respective growths; and accordingly on the wet and thin peat soil, where the more valuable hard wood will not grow, alder, birch, poplar, and Huntingdon and tree willows were substituted; whilst a larger proportion of oak, ash, elm, beech and sycamore, occupies the dry land, and the better kind of wet land, which, as before observed, had been previously fitted for its reception by draining.

The cost of the trees, with the expence of carriage, and planting, amounted to 2*l.* 16*s.* per acre, with an addition of 8*s.* per acre for upholding the plants for 3 years, and replacing every season such as died. The respective quantities of each of the different kinds will be seen in the following statement, which is verified by the inclosed certificates of the planters.

KINDS.	Number planted between Nov. 1816, and April 1817.	Ditto planted in 1817-18 to replace such as had failed.	Ditto 1818-19.
Larches . . .	647,156	186,512	146,460
Scotch Firs . .	504,208	39,252	31,890
Spruce . . .	43,860	3,324	3,125
Silver Firs . .	122	—	—
Oaks	125,988	11,200	9,304
Ashes	77,601	3,700	5,213
Elms	50,883	2,300	960
Beech	17,562	700	300
Sycamore . . .	30,768	500	102
Alder	19,143	367	102
Birch	7,172	185	102
Poplar	5,180	123	—
Willows . . .	3,508	122	102
Hornbeam . .	1,224	—	
Chesnuts and Ornamental trees	745	—	—
		—	—
	1,535,120	248,285	197,660

It will be seen by the above statement, that the trees originally planted amount to 1,535,120, and that 445,945 have been since added to supply the place of those that had failed. The hardiness of the Scotch fir, and the great advantage to be expected from the shelter it affords to such trees as are less capable of bearing an exposed situation, have led to the introduction of a much greater number of that kind than the value or usefulness of its wood might seem to recommend, but as a large proportion of the aggregate number of trees planted, must in due time be thinned out, this description, when its useful object is answered, will principally be removed to afford room for those more valuable trees which it has contributed to nurse. The larches have required considerably the most replacing, but this circumstance was occasioned by the ravages of a small insect, resembling the wire worm, from

½ to ¾ of an inch in length, which preyed upon the roots, and thereby destroyed the plants. Fortunately the injury was confined exclusively to the larches, and to such of these only as were planted on the dry soils, where they were expected to thrive the best. From 10 to 20 worms, and sometimes more, have been observed at the roots of one plant.

At the present time the whole plantation presents a healthy and thriving appearance; and to meet any future deficiencies that may possibly occur, a plot of ground containing about one acre near the plantation, has been trenched, and planted with seedlings of different descriptions.

The great extent of this plantation, the length of its boundary fences, and the risk that such parts of them as were made by adjoining proprietors (which constitute upwards of ⅓ of the whole) might, if insufficiently attended to, allow the trespassing of cattle, made it desirable to place some person on the spot, whose vigilance might preserve the plantation from trespass, and who would promptly repair any gaps that might be made in the walls, as well as replace such plants as should chance to die after the expiration of the three years, during which they were to be maintained by the original planters. But as these objects alone were insufficient for the constant employment of the person who was selected for this important trust, a plot of 42 acres of the best land the allotment contained, situated about the middle of the tract, was fenced round, and converted into a farm, with the addition of a cottage and suitable out-buildings, for its occupation. The fence which separates this farm from the plantation, and those boundary fences also which are made by the owners of adjoining allotments, are principally quicksets, protected by railing placed on the top of a cam or earthen mound about 3 feet in height; the rest

of the fences which inclose this plantation are good and substantial stone walls 6 quarters high.

It may not be improper to mention, that in addition to this plantation several smaller ones, containing together 5 acres, 1 rood, 34 poles, were also made, upon similar principles, on the other two allotments, between the months of November 1816, and April 1817. The total quantity therefore of land planted by his Grace at that time, amounts to 555 acres, 3 roods; and the trees to 1,550,470.

In thus bringing before the Society, as a candidate for the honour of its reward, the noble individual whose views in this extensive undertaking it has been my duty to carry into effect, I indulge the hope, that the magnitude of the object attained, and the measures adopted for its accomplishment, as detailed in the foregoing communication, may be considered not undeserving the favourable notice of the Society.

I am, Sir,

&c. &c. &c.

JOHN MACHELL,

Agent to his Grace,

the Duke of Devonshire.

A. Aikin, Esq,

Secretary, &c. &c.

CERTIFICATES.

WE the undersigned do hereby certify, that we are well acquainted with the High Stand plantation belonging to his Grace the Duke of Devonshire, and that we consider the foregoing to be a faithful and correct statement.

As witness our hands the 2nd day of February 1820.

JOHN HARRISON, *Minister of Hesket, in the Forest.*

JAMES WATSON, *Land Surveyor, Low Plains.*

Number of Forest Trees planted upon High Stand, in 1817.

Larch firs	57,300
Scotch firs	38,600
Ash	7,100
Elms	7,400
Oaks	7,400
Beech	4,400
Alders	3,900
Spruce	4,500
Mountain ash	1,400
Poplars, of sorts	600
Ornamental trees, of sorts	500
Total . .	133,100
To filling up in 1818 . .	13,200 of various sorts.
Do. in 1819 . .	22,000 Do.
In all . .	168,300

W. & T. Hutton, *Planters.*

A description of Trees planted on the High Stand, the property of his Grace the Duke of Devonshire.

Dec. 1816, 1817.	Larches .	68,000
	Firs . .	40,000
	Oaks . .	12,000
	Ashes . .	4,000
	Sycamores	4,000
	Beeches .	3,000
	Elms . .	5,000
	Alders .	4,000
	Birches .	2,000
	Spruce .	1,000
	Poplars .	1,000
	Planted 1st year	144,000

			Brought forward 144,000
1818.	Larches .	20,000	
	Firs . .	4,000	
	Oaks . .	1,000	
	Ashes. .	500	
	Sycamores	500	
	Beeches .	500	
	Elms . .	2,000	
			To fill up 2nd year 28,500
1819.	Larches .	10,000	
	Firs . .	2,000	
	Oaks . .	500	
	Ashes .	200	
			To fill up 3rd year 12,700
			Total planted 185,200

I do hereby certify that this is a correct statement of the Trees planted by me on the High Stand.

ADAM SMILLIE, *Planter.*

A description of Trees planted on the High Stand, the property of his Grace the Duke of Devonshire.

Dec. 1816, 1817.	Larches . .	391,500
	Scotch firs	195,700
	Spruce firs	20,000
	Oaks . .	87,850
	Ashes . .	43,925
	Elms . .	20,000
	Sycamores	10,000
	Beeches .	6,000
	Alders .	5,000
	Birches .	1,500
	Poplars .	1,500
		782,975 planted the first year.

1818.	Larches .	110,000
	Scotch firs	12,000
	Oaks . .	10,000
	Ashes . .	3,000
	Spruce firs	2,000
		137,000 to fill up the second year.
1819.	Larches .	95,000
	Scotch firs	8,000
	Spruce firs	1,500
	Oaks. . .	8,000
	Ashes . .	4,000
		116,500 to fill up the third year.

I do hereby certify that this is a correct statement of the Trees planted by me on the High Stand.

JOHN MOSES, *Planter.*

Hassendeanburn, near Hawick,
28th January, 1820.

Trees planted on High Stand plantation, belonging to his Grace the Duke of Devonshire, by Arch. Dickson and Sons, Nurserymen, Hassendeanburn.

1816.	3,000	Alders, 20 to 30 inches.
Nov. 29th.	3,000	Elms, 20 to 30 inches.
	3,000	*Planes, 20 to 30 inches.
	3,000	Oaks, 1½ to 2 feet.
	600	Beeches, 10 to 18 inches.
	360	Mountain ashes, 20 to 30 inches
Dec. 3rd.	600	Norway spruce, 10 to 16 inches.
	3,000	Ashes, 20 to 30 inches.
	3,000	Elms, 20 to 30 inches.
	3,000	Planes, 20 to 30 inches.
	22,560	(Carried forward.)

* The wood *Plane* is used in this list in the Scotch sense, signifying Sycamore. *Sec.*

Dec. 3rd.	22,560	(Brought forward.)
	3,000	Oaks, 1½ to 2 feet.
	600	Beeches, 10 to 15 inches.
1817.	360	Mountain ashes, 20 to 30 inches.
Feb. 11th.	3,000	Ashes, 20 to 30 inches.
	3,000	Elms, 20 to 30 inches.
	3,000	Planes, 20 to 30 inches.
	1,810	Oaks, 1 to 1½ foot.
	1,200	Spruce, 10 to 16 inches.
	360	Mountain ashes, 20 to 30 inches.
Mar. 5th.	31,200	Scotch firs, 1 year transplanted.
	12,000	Larch, 10 to 16 inches.
	2,400	Ash, 16 to 24 inches.
	1,200	Planes, 12 to 15 inches.
	1,200	Elms, 15 to 18 inches.
	1,200	Norway spruces, 9 to 12 inches.
7th.	2,760	Oaks, 10 to 16 inches.
	3,000	Ash, 15 to 20 inches.
	3,360	Elms, 15 to 20 inches.
	2,640	Planes, 15 to 20 inches.
	360	Mountain ashes, 15 to 18 inches.
	1,200	Norway spruces, 9 to 12 inches.
	24,000	Scotch firs, 1 year transplanted.
	6,000	Ditto, 2 years ditto.
	12,000	Larches, 9 to 14 inches.
	2,400	Ditto, 10 to 18 inches.
	600	Beeches, 10 to 14 inches.
11th.	3,600	Oaks, 10 to 16 inches.
	2,760	Ashes, 10 to 18 inches.
	2,160	Elms, 15 to 18 inches.
	1,800	Planes, 15 to 18 inches.
	480	Mountain ashes, 18 to 24 inches
	600	Beeches, 10 to 14 inches.
	157,810	(Carried forward.)

	157,810	(Brought forward.)
Mar. 11th.	2,400	Spruce, 10 to 14 inches.
	16,800	Larches, 1 to 1½ foot.
	28,800	Scotch firs, 1 year transplanted.
	6,000	Ditto, 2 years ditto.
	480	Hornbeams, 1½ to 2 feet.
	240	Horse chesnuts, 2 to 2½ feet.
14th.	3,000	Oaks, 18 to 21 inches.
	3,000	Ashes, 1½ to 2 feet.
	1,800	Elms, 2 feet.
	1,200	Planes, 2 feet.
	1,200	Beeches, 8 to 12 inches.
	240	Mountain ashes, 1½ foot.
	360	Hornbeams, 1½ to 2 feet.
	1,800	Norway spruce, 8 to 15 inches.
	30,000	Scotch firs, 1 year transplanted.
	14,400	Ditto, 2 years transplanted.
	14,400	Larches, 10 to 18 inches.
	9,600	Ditto, 8 to 14 inches.
18th.	1,200	Norway spruce, 1 to 1½ foot.
	1,200	Ash, 1½ to 2 feet.
	600	Elms, 16 to 21 inches.
	600	Planes, 18 to 21 inches.
	1,200	Oaks, 9 to 15 inches.
	480	Beech, 1 to 1½ foot.
	240	Mountain ash, 15 to 18 inches.
	360	Hornbeams, 20 to 30 inches.
	20,400	Larches, 10 to 18 inches.
	15,600	Ditto, 9 to 15 inches.
	12,000	Scotch firs, 2 years transplanted.
	2,400	Ditto, 1 year ditto.
21st.	1,320	Huntingdon willows, 1½ to 2 feet.
	600	Dutch ditto, 1½ to 2 feet.
	351,730	(Carried forward.)

	351,730	(Brought forward.)
Mar. 21st.	1,200	Black Italian poplars, 1 to 1½ foot.
	2,400	Birch, 1½ to 2 feet.
	960	Alders, 15 to 18 inches.
	960	Ditto, 24 to 30 inches.
	120	White poplars, 18 to 24.
	2,400	Norway spruces, 7 to 12 inches.
	12,000	Larches, 6 to 12 inches.
	2,400	Ditto, 10 to 18 inches.
	19,200	Scotch firs, 1 year transplanted.
	14,400	Ditto, 2 years ditto.
26th.	6,000	Norway spruces, 6 to 9 inches.
	18,000	Scotch firs, 1 year transplanted.
	9,400	Ditto, 2 years transplanted.
	1,520	Huntingdon willows, 20 to 30 inches.
	1,200	Birches 1½ to 2 feet.
	1,200	Alders, 1½ to 2 feet.
	720	Black Italian poplars, 12 to 21 inches.
	6,600	Larches, 10 to 18 inches.
	120	Silver firs, 10 to 12 inches.
April 1st.	3,600	Larch, 1½ foot.
	3,600	Scotch firs, 1 year transplanted.
1818.	6,000	Ditto, 2 years ditto.
March 3rd.	18,000	Ditto, 2 years ditto.
	13,200	Larches, 10 to 18 inches.
	4,800	Ditto, 7 to 10 inches.
	1,200	Norway spruce, 7 to 12 inches.
	2,400	Scotch firs, 1 year transplanted.
	360	Alders, 12 to 15 inches.
	180	Birches, 1½ foot.
13th.	10,800	Larch, 9 to 15 inches.
27th.	6,000	Ditto, 1 to 1½ foot.
April 7th.	10,800	Ditto, 1 to 1½ foot.
	533,470	(Carried forward.)

	533,470	(Brought forward.)
April 7th.	240	Scotch firs, 2 years transplanted.
	120	Black Italian poplars, 2 feet.
	120	Huntingdon willows, 2 to 3 feet.
Nov. 12th.	100	Alders, 1 foot.
	100	Tree willows, 2 to 3 feet.
	100	Ashes, 2 feet.
	100	Elms, 2 feet.
	150	Oaks, 15 to 18 inches.
	100	Mountain ash, 2 feet.
	100	Birches, 15 to 18 inches.
	100	Planes, 2 feet.
	4,000	Scotch firs, 1 year transplanted.
	1,500	Ditto, 2 years ditto.
	7,000	Larch, 7 to 12 inches,
1819.	1,000	Spruce, 6 to 12 inches.
Feb. 1st.	8,000	Larch 8 to 16 inches.
	2,000	Scotch firs, 2 years transplanted.
	1,000	Ditto, 1 year ditto.
Dec. 3rd.	5,000	Ditto, 2 years ditto.
	5,000	Larches, 10 to 16 inches.
	300	Ashes 1½ foot.
	400	Elms, 1½ foot.
	300	Oaks, 12 to 15 inches.
	200	Spruces, 1 foot.
21st.	6,000	Scotch firs, 2 years transplanted.
	3,000	Larches, 8 to 16 inches.
	579,500	
	11,590	Incast of 2 to each hundred.
Total . .	591,090	

ARCHIBALD DICKSON & SONS.

High Stand Cottage,
January 31st, 1820.

I DO hereby certify that his Grace the Duke of Devon-

shire's High Stand Plantation is well and effectually fenced round; that the young trees appear to be in a healthy and flourishing condition; and that I have taken every possible pains to preserve the trees by preventing trespasses in the plantation.

CUTHBERT RAINE, *Woodman.*

N° II.

RECLAIMING WASTE LAND.

The GOLD MEDAL *of the Society, the Premium offered, was this Session awarded to* JOSEPH RIDGWAY, *Esq., of Ridgmont, near Bolton, Lancashire, for reclaiming* 81 *Acres of* WASTE LAND. *The following communication has been received from him on the subject.*

Ridgmont,
January 1st, 1820.

SIR;

I SHALL feel much obliged if you will have the goodness to lay before the Society for the encouragement of Arts, Manufactures, and Commerce, the following improvements I have made in cultivating Waste Land, which I trust will in some degree be applicable to the premiums in agriculture offered by them in 1819: premium 43, for improving Waste Land; hoping that on examining the following statements I may have some small claim to the premium offered. Towards the latter end of 1816 I began my improvements upon a part of Horwich Moor, situate in the parish of Dean and county of Lancaster, four miles north of Bolton-le-Moors, which

was inclosed under the powers of an act of parliament in 1815, and the quantity of land which I beg leave to submit to the notice of the Society as improved is 81 acres, 49 of which were covered with strong heath on black peat from 15 inches to 2 feet deep, part dry, part wet; 7 acres were rough uneven land, containing a great number of old stone pits, where stone had been got for ages for the repairs of the public and private roads, and for buildings; and about 25 acres were clay land, with about 6 inches of brown soil upon it, also part wet and part dry: this last produced a short bent grass of little value. The whole has undergone the following improvements:

	£.	s.	d.
The 49 acres of land, the heath was mown off, burned, and the ashes spread upon the land; part of it was very stony and uneven; and the clearing from stone, levelling, mowing, and burning the heath cost . . or, about 6*l.* per acre.	289	19	0
The rough stone pit land of 7 acres, levelled and cleaned cost . . . . . or, about 19*l* per acre.	132	0	0
The 25 acres, part dug with spade and levelled, cost little more than 2*l.* 2*s.* per acre, or	53	0	0
The quantity of draining in the whole was 906 perches, which was done by the piece, averaging 2 feet 4 inches deep, laid with stone sough, the main drains 12 inches square, the side drains, some 8 others 6 inches square, averaging the expense of about 2*s.* 4*d.* per lineal rod, the whole costing	100	3	0
Carried forward	£.575	2	0

	£.	s.	d.
Brought forward . . .	575	2	0
Upon the whole of this land, being very thin of soil and stoney, a great expense was incurred in collecting soil from the road-sides, and other places, where I could get any to cover it; after the land was cleaned of heath, levelled, and the wet parts drained, it underwent the following state of cultivation:			
Eleven acres were dug into butts, or lands for potatoes, with the spade, cost 7*l.* 3*s.* 4*d.* per acre, or	78	16	8
Eight acres were dug and levelled with the spade, and sown with oats; another portion of 40 acres, 1 rood, 32 poles, was part dug with the spade and part ploughed, and laid down for pasture and meadow; another portion of 20 acres, 23 poles, after being cleaned, levelled, and dressed, was bone-dusted for pasture, and the dung, lime, and compost, laid upon the whole 81 acres, is as follows:			
22,200 measures of lime, a measure being about one hundred weight, @ 11½*d.* per measure, is	1,063	14	4
880 tons compost and black dung, @ 11*s.* 6*d.* per ton	506	0	0
80 tons of small dung and soil, @ 5*s.* per ton	20	0	0
1,012 tons of black dung	480	0	0
2,040 measures of bone dust, @ 3*s.* 1½*d.* (This is not yet all spread, but ready when the weather will permit)	318	15	0
Carried forward . . .	£.3,042	8	0

	£.	s.	d.
Brought forward . . .	3,042	8	0
Sundry cart-work in collecting soil, scrapings of the road, labourers wages, not taken into the above account	426	0	0
Potatoe sets, and setting 11 acres, @ 10*l.* .	111	0	0
Oats, ploughing and sowing 25 acres . . .	51	0	0
One acre of wheat	3	15	0
The land is divided into 25 inclosures by good stone walls, 6 feet, 10 inches high, 801 perches, which cost 13*s.* 3*d.* per lineal rod	530	13	6
847 rods of do. 4 feet, 10 inches high, @ 8*s.* 2*d.*	345	18	2
Roads made for the use of the land, 52 rods @ 14*s.*	36	8	0
105 rods of do. @ 6*s.*	31	10	0
	£.4,578	12	8

From these improvements there have been the following crops taken:

A.	*R.*	*P.*		£.	s.	d.
11	0	0	of potatoes produced 2,640 ms. @2*s.*	264	0	0
25	0	0	of oats, very good, @ 8*l.*	200	0	0
32	0	0	mown of hay, very heavy crop, @ 5*l.*	160	0	0
1	0	0	of wheat	8	0	0
12	2	30	in pasture, crop worth	30	0	0
81	2	30		£.662	0	0

This land is situated in a very populous manufacturing country, and the object I had in view was to get the land improved as soon as possible; of course it has employed a very great number of hands. The land is laid down with

white clover, trefoil, rib grass, and the best meadow hay-seeds, intending to have the whole in grass and to remain so, and divided into small farms, for which purpose I have built four farm houses, with suitable barns and out-buildings, which cost me 960*l.* not taken into the account. The land was of little or no value, except a few acres. Upon an average I now consider it worth 2*l.* per acre per annum, at least.

Thus, Sir, I have endeavoured, in as brief and plain a manner as I could, to put you in possession of the original state of the land, and of the means I have used to improve a very poor piece of waste uncultivated land, amounting to 81 acres, 2 roods, 30 poles, which has cost me 4,578*l.* 12*s.* 8*d.*, or on an average 56*l.* per acre; perhaps I might have done it at some less expense in the quantity of manure for the present, but I wished it to be done so as to continue a good herbage, as I do not intend it to be again broke up, but to lie as permanent pasture and meadow land. If any further information is required, I shall be happy to give it; and should my exertions obtain the favourable consideration and attention of the Society of Arts, &c. &c., it will afford me the highest gratification.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JOSEPH RIDGWAY.

N. B.—A plan is herewith sent of the improved land.

CERTIFICATE.

WE whose names are hereunto subscribed, do certify that we knew the land before the improvements were made, and have seen it frequently during the time they

were going on, and we never saw waste-land better and more speedily and effectually made good. The stone walls for fences to the road sides are topped with triangular stones, set on an edge with lime mortar; the farm houses and out-buildings substantial, neat, and convenient, and the roads good: the crops were exceeding good and heavy, particularly the oats and hay grass. It was a part of Horwich Moor, situate in the parish of Dean, near Bolton, in the county palatine of Lancaster, and the property of Joseph Ridgway, Esq. of Ridgmont, in the said county; and we believe the annexed account is a true statement of the process and expense of improving the land, as well as of the produce reaped, and have the satisfaction to say we are confident it will be of great advantage to the neighbourhood.

THOMAS BROCKLEBANK, *Vicar of Dean.*
JOHN SHARPLES, *Churchwarden of Dean.*
RICHARD FLETCHER, JOHN ASHWORTH } *Commissioners for inclosing the said Moor.*
THOMAS PLUMPTON, *Agent to Joseph Ridgway, Esq.*

N° III.

CULTURE AND PREPARATION OF OPIUM IN BRITAIN.

Extract of a Letter from JOHN YOUNG, *Esq., Surgeon, Edinburgh, on the* CULTURE AND PREPARATION OF OPIUM IN BRITAIN, *supplementary to his communication on the same subject inserted in the 36th volume of the Transactions of the Society.*

Edinburgh,
March 15th, 1820.

SIR;

SINCE I had the honour to correspond with you on the subject of my communication to your Society respecting my mode of collecting British Opium, and for which I had the honour to receive the Gold Isis Medal, I was last summer engaged in the same experiment, on a larger scale than formerly, and I produced nineteen pounds and a half of opium, twenty-five gallons of poppy oil, and at the rate of 40 bolls of early potatoes, from 129 falls, 18 square yards, being 30 falls less than one acre of ground, by the mode of cultivating communicated to your Society, and afterwards more particularly detailed in the 2nd and 3rd Nos. of the Edinburgh Philosophical Journal, with this difference, that the gatherers collected the milky juice with their thumbs instead of brushes, which

I consider to be a material improvement in the mode of gathering; and although I had from 12 to 20 boys, from 12 to 14 years of age, employed during the season, only two were affected with drowsiness, and I could not be certain whether this was the effect of the absorption of the opium, or of the extreme heat of the weather. By this new mode of gathering the milky fluid of the poppy one of the boys, more than once during the season of gathering, filled his flask in one day, of ten hours work; the flask contained 14 oz. which, when evaporated, gave *three ounces and two drachms of solid opium*. I may observe that owing to the extreme heat and want of rain during the last opium harvest, my plants came so rapidly to maturity, that I did not get so much opium as I probably should have done, had there been occasional showers.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. JOHN YOUNG, *Surgeon.*

PAPERS

IN

CHEMISTRY.

N° I.

DISCOVERY OF CHROMATE OF IRON IN SHETLAND.

The smaller, or Isis Gold Medal *of the Society was this Session voted to* Samuel Hibbert, M. D., *of Edinburgh, for the discovery of* Chromate of Iron in Shetland. *The following communication has been received from him on the subject.*

5, Hill Place, Edinburgh,
February 7, 1820.

SIR;

I HAVE the honour to make a communication to the Society of Arts, &c. &c., respecting the discovery which I originally made two years and a half ago, of the Chromate of Iron in the Shetland Islands, which substance is at present obtained for the manufacturers of colours at a considerable expense from the United States of America. Since a notice first appeared in the journals relating to the discovery, considerable inquiries have been made concerning it; but, that I might not create expectations

which could not be realised, I was unwilling to make further communications on the subject until I had made a second visit to Shetland, when I ascertained that it exists there in great abundance. Conceiving, therefore, that the patriotic Institution of London for the promotion of the Arts and Commerce of Great Britain, was the most suitable medium through which the knowledge of the place and circumstances under which the chromate of iron is found might be first communicated to those who are commercially interested in the discovery, I have taken the liberty of transmitting to you a set of specimens,* which, in reference to the annexed description, will illustrate the varied character of the mineral. If my discovery shall be considered as a contribution to the commercial resources of the British Islands, it will afford me some recompense for the considerable time and labour which I have expended in the prosecution of the search after this important ore.

I am, Sir,

A. Aikin, Esq.,
Secretary, &c. &c.

&c. &c. &c.

SAMUEL HIBBERT, M.D.

Circumstances under which the Chromate of Iron is found in Shetland.

The Chromate of Iron occurs in the Serpentine rocks in the neighbourhood of Balta Sound, in the Island of Unst. I was first led to a search after this ore by observing innumerable fragments of it strewed about the hill in which it is found, and even contributing to strengthen the fences of the country. It is observed in the form of imbedded and insulated masses, at Buness, close to the house of the proprietor, Thomas Edmon-

* Which are now in the repository of the Society.

stone, esq. The extent of the greatest mass is not, however, ascertained, as it is on one side concealed by the sea, and on the other by the deep soil of a meadow. It was traced 3 feet in breadth and fifteen feet in length. At Hagdale, near Haroldwick, the chromate of iron occurs in the form of numerous thin ramifying veins, but these are only from 2 to 3 inches in breadth, sometimes increasing to the breadth of 5 or 6 inches. Many masses are elsewhere observable, extending a few feet and then losing themselves in a general dissemination throughout the serpentine rock in which they occur. This dissemination consists in the diffusion of granular particles of the colour and size of gunpowder.

It is evident from this description that the most promising appearance of the ore is adjoining the house of Mr. Edmonstone, and from this gentleman, whom I have made acquainted with all the circumstances of the mineral, any commercial inquiry will meet with the most satisfactory answer. Letters may be directed, "Thomas Edmonstone, Esq., of Buness, Island of Unst, Shetland."

Upon the encouragement, however, from London will depend the renewed searches after the chromate of iron, not only on Mr. Edmonstone's grounds, but in the adjoining hills, which are the joint property of several landed proprietors in Unst. From the quantity, therefore, of the ore which has been found in detached portions on the hills, and from the promising appearance on Mr. Edmonstone's grounds, I would submit to the manufacturing chemists in London the propriety of rendering to the Shetland gentlemen every scientific assistance which they may require from their advice, or even if wanted, from other exertions in prosecuting the search after this ore, provided its quality suits their purpose. It appears to me that some serious obstacles cannot fail to

result from the inexperience of the Shetland gentlemen in whatever concerns the operations of mining.

Vessels trading from Leith to Shetland visit Balta Sound almost every month in the course of the Spring and Summer.

In furnishing the foregoing particulars relating to the chromate of iron, I have only to add that I shall be happy to answer any personal inquiries on the subject, concerning whatever I may have left unexplained.

SAMUEL HIBBERT, M. D.

Portions of the specimens of chromate of iron transmitted by Dr. Hibbert were put into the hands of several members of the Society for examination, with respect both to the quality and richness of the ore as compared with that imported from the United States. Samples of chromate of lead prepared from the American and Shetland varieties of chromate of iron were laid before the Committee by Mr. Midgley, one of the chairmen of the committee of chemistry, who has had large experience in this branch of chemical manufacture. The result of this gentleman's investigation (confirmed by the experiments made by other members of the Society) is, that the ore from Shetland in quality is quite equal to that imported from America, and in richness, as far as can be judged from a few specimens, is superior.

N° II.

GLASS HYDROMETER FOR SPIRITS.

The smaller, or ISIS SILVER MEDAL *was this Session voted to Mr.* HENRY STOKES, *of Hatton Garden, for his* HYDROMETER FOR SPIRITS. *The following communication has been received from the Candidate on the subject, and one of his Hydrometers has been placed in the repository of the Society.*

110, Hatton Garden,
March 7, 1820.

SIR;

I REQUEST, through you, to lay before the Society for the Encouragement of Arts, &c. &c., a Glass Hydrometer for ascertaining the specific gravity of spirits. This instrument will be found to possess quite sufficient accuracy for all practical purposes, is cheap, and of very easy application, as it requires the assistance neither of a book of tables, of a sliding rule, nor of weights. By means of it the value of a given spirit may be ascertained to one-fourth of a degree above or below proof; and hence I conceive it is likely to be of great service to those dealers in spirituous liquors who either object to the cost of the instruments employed by the excise and by the distillers, or who feel embarrassed in making the calculations required for the correct employment of them. The very fragility also of the material of which it is made (which by

many may at first sight be considered as an objection to the use of it) is in fact, if duly considered, a real advantage. Accidents will occasionally occur in the use of the hydrometer as of every other instrument, either by letting it fall on the ground, or by its coming too rudely in contact with other hard substances. When this happens to a hydrometer made of metal, the ball of it being thin, will be more or less indented, and therefore, in a degree proportioned to the injury, will be rendered ever after incorrect. Many persons in the habitual use of the hydrometer are entirely ignorant of the principles on which it acts, and therefore of the injury which the slightest indentation will inflict on its accuracy, and consequently on its utility; and even those who are well aware of this will feel no small reluctance to discard an expensive instrument, unless the injury which it has received should be considerable. By the employment of the glass hydrometer, on the contrary, all sources of error arising from casual injury are effectually prevented: a slight blow, such as would, in a small degree, derange the metallic hydrometer by indenting it, will not affect the glass hydrometer on account of the elasticity of the material; and a harder blow, by breaking the instrument, puts the possessor indeed to the expense of a new one, but at the same time secures him from the errors arising from the use of a defective instrument.

The only real objection to the use of glass hydrometers is, that, as made hitherto, they have not been sufficiently comparable one with another; this is, however, entirely obviated in the instruments of my construction; three of which, differing in the length of their respective stems, accompany this communication, and which I beg leave respectfully to recommend to be put by the Committee to the test of experiment.

The graduation of the instruments is made to corres-

pond exactly with that projected by Sikes, and at present employed by the excise. Their construction may be explained in a few words, and their use by means of an example.

Reference to the Plate of Mr. STOKES's *Hydrometer.*

A, fig. 4, plate I, is a spherical ball, with a short tube at the bottom, connecting with a smaller bulb B, in which is contained the quicksilver requisite to bring the instrument to its real weight so as to correspond with the scale. The stem C C is about seven inches long, and contains a double scale, one D, coloured, the other E, white or plain. These scales are drawn on paper, which is introduced into the hollow of the stem, and being fixed by means of cement at the lower end, is afterwards prevented from derangement or injury by hermetically sealing the mouth of the stem. Fig. 3 represents the scale taken out of the stem, and laid on a plain surface, the shaded part representing the coloured scale. This latter is that by which the proper correction for temperature is obtained, as indicated by the small thermometer, fig. 2. The plain scale of the hydrometer shows the per-centage of the spirit above or below proof, and can be extended, if required (upward) to 70 per cent over proof, or (downward) to water. The thermometer is divided into 15 degrees more or less, and each division subdivided into halves and quarters, computed from zero or 0 upward, and from the same point downward, to the extent of the tube. The words 'add,' below zero, and 'subtract' above the same, show the number of degrees to be added to, or subtracted from the line of indication on the coloured scale of the hydrometer; such number being the variation of the temperature from the point zero, above or below, is thus used to ascertain the real from the apparent indication.

Directions for the use of the Instrument.

Fill a glass cylinder nearly with the spirit which is to be tried, and immerse the hydrometer therein to the depth of the ball; suffer it then to sink until it find its resting point. When the instrument at length becomes quite stationary, observe what number of degrees marked on the *coloured* part of the scale within the stem corresponds with the surface of the spirit—suppose it be $27\frac{3}{4}$; place this number on a slip of paper: this done, the hydrometer is to be taken out, and the thermometer dipped into the spirit, in order to ascertain the temperature of the latter. Observe now the point or degree at which the quicksilver settles—suppose it be $2\frac{1}{2}$ *below* zero or 0; place this number down also on the slip of paper under the $27\frac{3}{4}$, and *add* them together thus: $\begin{array}{r} 27\frac{3}{4} \\ 2\frac{1}{2} \\ \hline 30\frac{1}{4} \end{array}$, making a sum of $30\frac{1}{4}$. Look, in the next place, for $30\frac{1}{4}$ on the coloured scale, in a line with which, on the white or plain scale, will be found 18.2. This last number is the per-centage *above proof* of the spirit, and corresponds exactly with what would be determined by Sikes's hydrometer.

But suppose, secondly, the resting point of the hydrometer and corresponding surface of the spirit be 22.0 on the coloured scale; and on the hydrometer being again drawn and the thermometer immersed, that the quicksilver in the latter should stand at $2\frac{1}{4}$ *above* 0, place these two numbers down as before, and *subtract* the lower from the upper, thus: $\begin{array}{r} 22.0 \\ 2\frac{1}{4} \\ \hline 19\frac{3}{4} \end{array}$, the number remaining indicates the strength of the spirit; which at $19\frac{3}{4}$, as in this example, is exactly of *proof strength*, as shown by Sikes's hydrometer.

Thirdly, suppose the indication or surface number of

degrees on the coloured scale, when the hydrometer is at its subsiding point, to be 14¼, and the quicksilver in the thermometer (on its subsequent immersion) to settle at 0; it being obvious here that there is no number either to add or to subtract, a reference to the white or plain scale alone will be sufficient. The per-centage or strength of the spirit will, in this case, be indicated by that number of degrees on the plain scale which stands level with the surface of the spirit; and the strength of the latter will, in this example, be found to be 10 per cent under proof.

		s.	*d.*	
Price in detail	Glass Hydrometer	14	0	£.1 10*s.* price complete.
	Ivory Thermometer	10	0	
	Glass Cylinder . .	2	6	
	Box	3	6	

Any part of the apparatus may be replaced at the above prices.

HENRY STOKES.

N° III.

MARINE THERMOMETER CASE.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* ROBERT JAMIESON, *Mathematical Instrument Maker, Glasgow, for a* MARINE THERMOMETER CASE. *The following communications have been received from him on the subject, and the instrument itself is placed in the Repository of the Society.*

Glasgow,
March 10, 1820.

SIR;

I BEG leave, through you, to present for the inspection of the Society, a Marine Thermometer Case which I have constructed for captain Livingston. The directions given to me by that gentleman, were, to make a case capable of preserving a thermometer from being broken when lowered into the sea, and drawn up again from the side of a ship; also, that it should admit water at any given depth, and retain it during the drawing up of the instrument, so as to enable a thermometer of the usual construction to indicate the temperature at different depths, undisturbed by the greater or inferior heat of the surface water.

The accompanying statement, drawn up by captain Livingston and confirmed by his own experience, of the utility of thermometrical observations to the navigator, renders wholly unnecessary any remarks of mine on the

same subject. I shall therefore confine myself to the mechanical construction of the instrument as exhibited in the drawing and model herewith transmitted. In order to answer its purpose, it was necessary to combine in the construction, strength, simplicity and portability; but although these objects have been attained so as to produce a practically advantageous result, I am far from claiming for it absolute perfection. Longer experience and greater skill will probably be able to improve upon the present first attempt; and it is with this view, and also in order to call the public attention to a subject which promises to be highly beneficial to this maritime nation, that I have taken the liberty of offering the instrument to the notice and encouragement of your patriotic Society.

I am, Sir,

&c. &c. &c.

ROBERT JAMIESON.

Reference to the engraving of Mr. JAMIESON'S *Marine Thermometer Case,* Plate XV.

Fig. 5 is an exterior view of the instrument, and fig. 3 is a section of the same, with the inclosed thermometer.

The general form of the case is that of a cylinder or tube of copper, one-eighth of an inch in thickness, and seventeen inches in length; each end is open, and is bevelled off at the mouth for the more free admission of water.

v is the handle for the purpose of fixing it to the end of a cord. This handle is moveable on two pivots, by means of which it can readily be thrown on one side when it is necessary to take out or put in the thermometer.

At $2\frac{1}{8}$ inches from the top, is the circular joint *o o*, by means of which the lid forms a water-tight joint with the

body of the case ; the lid is also furnished with a hinge, on which it may be thrown back.

The valves are placed at each extremity of the tube, the upper one opening outwards, and the lower one inwards : they are composed of the following parts :

p q, a short cylinder or box, bevelled at each extremity.

s s, a bridge or cross bar, bulging at the middle, and there perforated, for the purpose of receiving an upright pin, to the upper end of which is fixed the circular plate of the valve, and to the lower end a screwed stud *t*, the round head of which prevents the pin of the valve from being drawn, by the pressure of the water, through the perforation in the cross bar.

r r, a circular projection, on which the bottom of the thermometer rests.

From this description, it is obvious that when the case containing the thermometer, and having its lid carefully closed, is dropped into the sea with a line attached to the handle, it sinks rapidly in nearly a vertical direction, and at the same time the pressure of the water throws up both the valves. In consequence of this, a current of water is constantly passing through the case while the instrument continues to sink. As soon, however, as by the check of the cord the instrument becomes stationary, the valves fall into their places, and intercept the escape of the water; the quicker the cord is drawn up, the more completely are the valves secured, and the influx of the upper water the more perfectly prevented. As soon as the case comes to hand, the lid is to be thrown back and the thermometer withdrawn just sufficiently to enable the observer to read off the degree at which the mercury stands.

44, Adelphi-street, Hutcheson Town, Glasgow,
February 25th, 1820.

DEAR SIR;

As I understand you have advised Mr. Jamieson, mathematical instrument maker of this city, to submit the model of the Marine Thermometer Case constructed by him, for my use, to the notice of the Society for the Encouragement of Arts, &c., &c., and that you have expressed a wish to have a written statement of the causes which led to my application to Mr. Jamieson, in consequence of which, he was led to undertake the construction of that instrument, and also of my opinion of its utility for nautical purposes, I shall endeavour to comply with your wishes as concisely as in my power; though I am much afraid the detail into which I must necessarily enter, will not admit of all the brevity which might be desirable.

My attention was first directed to the thermometer, as a valuable nautical instrument, by the excellent memoir compiled by Mr. John Purdy, hydrographer, London, to accompany the admirable Chart of the North Atlantic Ocean, constructed by him, and published by Messrs. Whittle and Laurie, of 53, Fleet-street, in the year 1812.

The late celebrated Dr. Benjamin Franklin, was, I believe, the first person who suggested the utility of the thermometer as an indicator of the *proximity of*, or an *approach to*, the American coast, having remarked the great difference of temperature between the water of the Gulf stream as it sweeps along the coasts of the United States, and the water upon the soundings between the inner edge of the stream and the shore.

This interesting subject was afterwards taken up by colonel Jonathan Williams, who endeavoured, with some success, to attract the attention of nautical men to the vast importance of the thermometer, in an ingenious work

intituled "Thermometrical Navigation," published at Philadelphia, in 1799.

To avoid unnecessarily extending the length of this letter, by quoting evidence already before the public, I beg to refer to the third edition of the Memoir by Mr. Purdy, already mentioned, the perusal of which must satisfy the most sceptical, that the thermometer is not only a certain indicator of the proximity of the American coast, but also an infallible monitor of an approach to islands of ice, so perilous to navigators, and the dangers of which are tenfold increased by the circumstance of their being generally surrounded by dense fogs. Mr. P.'s Memoir, from the 73rd to the 78th page, is occupied with these important subjects.

Colonel Williams recommends that the thermometer should be slung, "so as to tow in the dead water of the ship's wake." I tried this mode, and had three of my thermometers broken in consequence; *this* led me first to think of having a case to prevent my instruments from being fractured by any accidental contact with the ship. Some gentlemen, whose opinions I respected, suggested that while towed by the ship, her way through the water would naturally cause the thermometer to rise to the surface, and that thus only the temperature of the surface water could be obtained, and that they conceived this temperature liable to be influenced by the effects of the solar rays. To obviate this objection, I saw the necessity of a case to inclose the thermometer, which would admit the water freely as long as it was permitted to descend, but would shut as soon as it was begun to be hauled up.

After I was satisfied how useful a thermometer case, adapted properly for these purposes, must prove, I applied to various mechanics in different places to construct one

for me, but they either did not sufficiently understand the matter, or considered the safety of human lives and merchants ships and cargoes of too trivial importance to induce them to exercise their abilities; be this as it may, I was always disappointed of my object, until I became accidentally acquainted with Mr. Jamieson, who readily entered into my views, and made a case for my thermometer, which completely answers my ideas, of which the model intended to be sent to the Honourable the Society of Arts, &c. is, as you know, a correct copy, *i. e.* allowing for the difference of sizes, the original case being $1\frac{4}{10}$ inch in diameter within, which I consider large enough to contain a column of water that will retain its original temperature a sufficient space of time (after the case is hauled up), to allow of the degrees indicated by the scale being read off by the observer, which is all that is necessary; while, if the magnitude of the apparatus had been increased, it must have become almost useless from its weight, when a vessel had fresh way through the water, and by the time she came to run eight or nine knots, must have been totally unserviceable. The same objection applies to any addition of weight.

The objection to Jamieson's Marine Thermometer Case, which has I understand been made, that the valves do not permit a sufficient column of water to pass completely to fill the interior of the case in a constant stream as it descends, appears to me of little importance, as enough must pass through to regulate the altitude of the mercury in the thermometer tube, and before there can possibly be time to haul up any part of the attached line, the mere pressure of the water must infallibly fill the thermometer case.

Purdy's Memoir shows incontestibly that no vessel on board of which there is a thermometer, can possibly run ashore on the coasts of the United States of America to the northward of the Strait of Florida, without her com-

mander (unless he is guilty of the most culpable negligence) having at least warning in sufficient time to avoid the danger (*i. e.* if his vessel is not so much crippled as to render it impossible for him to use any means to get off shore); and various circumstances induce me to hope that the thermometer will ultimately be found not only an indicator of an approach to the coasts of the United States, but also, that it will point out the proximity of land or soundings in *all* places to the northward of the Tropics, and probably also to the southward of them, though my own experience does not warrant me in the hope that it will within them.

Besides these advantages, the use of the thermometer has already been ascertained as illustrative of several of the oceanic currents. The venerable and indefatigable geographer, major Rennell, in a letter to myself dated 6th of November last, observes, "*The current from the Indian Ocean round the Cape of Good Hope differs* 10° *from the Ocean water,* i. e. *is* WARMER; *the* EQUATORIAL CURRENT *colder by* 5 *or* 6 *deg. than the Guinea current, which* BRUSHES *it in passing, &c.*" Thus far already established. We may surely venture to hope that as thermometrical observations are multiplied, their utility will become more obvious, and be more generally acknowledged.

In my own experience I have found a difference of 12 deg. in the temperature of the water in a few hours. Running out of the Delaware, in 9 fathoms water, the mercury stood at 60 deg. (in October 1817); as the water deepened, it rose to 64 deg.; and as we entered into the Gulf stream, it suddenly increased to 72 deg.

In September 1818, when bound from New Orleans to Gibraltar, in the ship Asia, of Scarborough, then under my command, a fever broke out on board the ship, and for a considerable number of days after we cleared the Strait of Florida, we had only four men and a boy fit for duty,

and three out of that number merely convalescents. I was myself confined to bed, and my mate in the same situation; we were the only two navigators on board, and both unable to make up any reckoning, and some days unable even to crawl on deck to take an observation at noon. In this dilemma I trusted entirely to my thermometers, having given orders that the instant the mercury fell two or three degrees, the ship's head should be wore round off shore. In this way I kept the ship from danger, and also availed myself of the Gulf stream current to carry us to the northward, and I really believe that under Divine Providence, the safety of the ship, cargo, and crew, was attributable to my thermometers.

On the same voyage, on approaching very near the Azores Islands, the mercury sank 2 deg., and when we made the coast of Portugal, it rapidly fell from 69 deg. to 61 deg., at which it stood when we rounded Cape St. Vincent, at the distance of about a league. After we passed that promontory, the mercury again rose to 69 deg., at which it continued until the ship entered the Strait of Gibraltar. In the Strait the wind was adverse; and in beating through it, the mercury stood at 68 deg. in the middle of the Strait, 64 deg. on the Spanish shore, and 61 deg. on the African coast: this difference between the temperature on the Spanish and African shores is apparently easily accounted for, as we stood much closer to the latter, avoiding the former on account of the rocks and shoals to the westward of Tariffa; yet as we found the mercury at our anchorage in Gibraltar Bay stood at 64 deg., perhaps there really was a difference of temperature in the water on the opposite shores: this was in October, 1818. Major Rennell, to whom science is under so many obligations, has communicated to me, that captain Beaufort, of the Royal Navy, found a difference of 10 deg. between the water in the middle of the Strait and

that in Gibraltar Bay, but I am not aware at what season Captain Beaufort's experiments were made.

Since Mr. Jamieson completed the thermometer case for me I carried it down to Greenock, and exhibited it to Mr. Colin Lamont, Mr. Quintin Leitch, and Mr. William Heron. Mr. Leitch procured a boat, and we went off, and made a number of experiments, which proved completely satisfactory.

My opinion of Jamieson's Marine Thermometer Case is, that the simplicity of its construction, and its strength, render it as complete a thing as could be desired for the purpose for which it is intended. I fully concur in the opinion expressed in the certificate by Messrs. Lamont, Leitch, and Heron; and I am decidedly of opinion that either to increase the size, or to add lead to it to increase the weight, will never be proposed by any *practical* seaman.

The mode in which I propose to use the apparatus is, by making about 20 fathoms of strong line fast to it,—to cause the officer of the watch to stand aft with the end of the line made secure to one of the staunchions, or some other thing, lest it should accidentally slip through his hands, and the whole be lost; he must then cause the apparatus to be passed forward, as in heaving the deep sea lead: when the vessel has much way through the water, it may be passed to the bowsprit end, and dropped (not hove) from it; but for general use the fore-chains may be far enough: when all is ready, let the officer call out to *let go*, and when that is done he must immediately haul in the line, and when he gets hold of the case, open it, and draw out the thermometer a sufficient length to read off the altitude of the mercury indicated by the scale, which he ought immediately to mark on the log slate, in a column which should be traced upon the slate for the purpose.

In my own practice I have always caused two columns to be marked, the one T. A. for temperature of the air, the other T. W. for temperature of the water. In these columns I ordered the officer of the watch to insert the temperature both of the air and water twice (sometimes oftener) each watch. The temperature of the air is, however, of little importance farther than as a comparative observation, it being only the variations of temperature in the water which are of importance to the navigator.

In reading off, the observer should take care to keep as much of the thermometer as possible immersed in the water, which this marine case allows of being done with facility.

I have said enough to convince you of the immense importance of the thermometer as a nautical instrument, and that Mr. Jamieson's Marine Case renders the use of it both more easy and certain.

I am, Sir,

William Warren, Esq. ANDREW LIVINGSTON,
Shipmaster.

P. S. You are at perfect liberty to use this letter in any mode you think may be advantageous to Mr. Jamieson, whom I consider entitled to much credit for this simple and useful invention. A. L.

2nd P. S. Since writing the above, Mr. Jamieson has informed me that he is anxious to send the instrument with which the experiments were actually made at Greenock, and begged me to let him have it, promising to replace it to me; although with some reluctance I have complied, thus the Society of Arts will actually have the real marine thermometer case in place of a model; and I doubt not but the scientific members of that honourable body, will neither wish its size or weight increased, whatever individuals (here) ignorant of seamanship may say. A. L.

N° IV.

IMPROVED GLAZE FOR PORCELAIN.

The smaller or ISIS GOLD MEDAL *was this Session voted to Mr.* JOHN ROSE, *of Coalport, Shropshire, for an* IMPROVED GLAZE FOR PORCELAIN. *The following communication on the subject has been received from the candidate, and specimens of the Felspar, the principal ingredient of the Glaze, of the entire glaze ready mixed for use, and of the Porcelain in a finished state, have been placed in the Society's Repository.*

Coalport,
March 24th, 1820.

SIR;

HAVING for some time made use of a glaze for porcelain, which gives me great satisfaction, and into the composition of which, neither lead nor arsenic are admitted, I beg leave to submit the same to the consideration of the Society of Arts, &c.

The common glaze for porcelain and the finer kinds of earthenware contains a considerable proportion of glass of lead; this ingredient however, on account of its being mixed with a certain proportion of siliceous earth and other vitrefiable materials, unites with them into a glass, which although easily fusible, is not in the least corroded or acted on by any articles of food. It is not, therefore, from the apprehension of any injury to the health of those who use vessels of porcelain, that the use of lead in the

glaze is objectionable, but because it is extremely liable to combine with, and degrade the more delicate colours, especially those given by preparations of chrome and of gold. This is particularly the case in the more expensive and elaborate products which, on account of the multiplicity of their colours, require to be repeatedly heated, or *fired*. I trust, therefore, that the Society will consider the communication of a receipt for glazing, in which the above mentioned defects are avoided, as worthy of their favourable notice.

The principal ingredient of my glaze is felspar, of a somewhat compact texture, and a pale flesh red colour, which forms veins in a slaty rock adjoining to the town of Welsh Pool, in Montgomeryshire. This material being freed from all adhering pieces of slate and of quartz, is ground to a fine powder, and being thus prepared, I mix with 27 parts of felspar, 18 of borax, 4 of Lynn sand, 3 of nitre, 3 of soda, and 3 of Cornwall China clay. This mixture is to be melted to a frit, and is then to be ground to a fine powder, 3 parts of calcined borax being added previously to the grinding.

The specimens accompanying this letter, are,

1. The felspar in its rough state.
2. Do. ground to a fine powder.
3. Some of the glaze ready prepared for dipping.
4. Specimens of porcelain glazed.
5. Do. both glazed and afterwards painted, in order to show the solidity and brilliancy of the colours when used on this glaze.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JOHN ROSE.

Some of the specimens furnished by Mr. Rose were placed by the committee in the hands of Mr. Muss, and of

other artists, in order to be submitted to experiment both with regard to the perfection of the glaze itself at high temperatures, and its re-action on the several colouring materials.

Mr. Muss's trial pieces were proved first in a common kiln, and afterwards were subjected to the action of a much higher degree of heat than it is possible that they can ever be exposed to in the fair course of enamelling. In this extreme heat the ground of the ware is not in the least degree softened or affected; the glaze remains firm and perfectly uniform without any specks or spits having been produced on its surface; the colours, even the pinks and chrome greens, come out remarkably well upon it. Mr. Rose's glaze not being so hard as that used by the French manufacturers, incorporates more completely with the colours, and renders them perfectly firm, whereas, every artist knows that colours laid on French porcelain are extremely apt to chip off, crackle, and flake, if it is necessary to make them pass the fire a second time. On the whole, therefore, Mr. Muss considers the samples placed in his hands by the committee, as the best both in body and glaze that have ever come under his observation.

Similar reports of the excellency of the glaze, in the particulars above mentioned, were made by the other artists who had made trial of it.

PAPERS
IN
POLITE ARTS.

N° I.

PARALLEL RULE.

The smaller, or ISIS SILVER MEDAL *of the Society was this Session voted to Mr.* ARTHUR HARRISON, *of Charlotte Street, Rathbone Place, for a* PARALLEL RULE *for the use of Engravers. The following communication has been received from the candidate, and the Instrument is placed in the Society's Repository.*

4, Charlotte Street, Rathbone Place,
November 2, 1819.

SIR;

I REQUEST that you will lay before the Society of Arts, &c. &c., the accompanying parallel rule which I trust will be considered as deserving of their favourable notice. It will be found in use to allow the hand of the artist to traverse freely from one side to the other without the interruption experienced in those of the common construction by the projection of the brass pieces on which their movements depend. The greater regularity of the

lines thus produced, although an important advantage to the draftsman, will, I trust, prove of especial use to the engraver, in whose works perfect precision of execution is indispensable. A farther advantage is, that rules of this construction are but little liable to be deranged by an accidental blow or fall, or to warp by heat or cold, by moisture or dryness.

The rule may be made of any length, without increasing its thickness, $\frac{1}{4}$ of an inch in each of the external plates being quite sufficient for securing the rivets. The movement may be either single or double, according to the use to which the instrument is to be applied.

I am, Sir,

Arthur Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. ARTHUR HARRISON.

References to the engraving of Mr. HARRISON'S *Parallel Rule,* Plate V.

Fig. 7, a view of the rule in its entire state.

Fig. 8, a sectional view, in which the three parallel plates of which it is composed are separated from each other; *r*, the middle plate; *q s*, the two outer ones.

Fig. 9 shows the brass hinges of the rule, after the upper plate and half of the middle plate have been removed; *q*, the under plate; *r*, half the middle one.

Fig. 10 shows the form given to each half of the middle plate in order to receive the hinges.

Fig. 11, the outside of half the upper or lower plate, in which is a semi-circular depression to receive the tip of the finger, and thus to move the rule forward or backward.

N° II.

PREVENTION OF FORGERY.

The Thanks of the Society were this Session voted to Messrs. PERKINS, FAIRMAN, *and* HEATH, *for their very liberal offer of communicating to the Society for publication in the ensuing Volume of Transactions, certain parts of their* SIDEROGRAPHIC *process for multiplying copies of engravings, particularly with a view to the* PREVENTION OF FORGERY. *The following communication has been received in consequence from the above-mentioned gentlemen.*

SIR;

THE Society for the Encouragement of Arts, Manufactures, and Commerce having devoted so much of their valuable time to investigating the different methods proposed for the prevention of the forgery of Bank notes, we, the proprietors of the Siderographic art, believe that a full account of our plan (which has been in successful operation many years in America, and is now adopted by many banks in this country) will not be thought unworthy of their attention.

We will, in the first place state what we consider to be the grand basis of *security* in this plan, and secondly, the means of executing it. Although it is certainly not a new idea, that the greatest security which could possibly be afforded in preventing forgery would be that of employing

a combination of the talents of the first-rate artists in fabricating a bank note plate, and of having the notes always *identically* the same; yet we conceive the following plan to effect this object is entirely new. It is the power of re-producing and multiplying the works of the greatest artists, which constitute the strength of this system; it is the basis on which we build our hopes. The method of multiplying engravings is as follows:

A steel plate (the method of preparing which will be hereafter described), is engraved or etched in the usual way; it is then hardened. A cylinder of very soft steel, of from 2 to 3 inches in diameter, is made to roll backwards and forwards on the surface of the steel plate, until the whole of the impression from the engraving is seen on the cylinder in alto-relievo: after this cylinder has been hardened, it is made to roll backwards and forwards on a copper or soft steel plate, and a perfect fac-simile of the original is produced of equal sharpness. The following calculations will show to what extent this system of preventing forgery may be carried.

Suppose 20 of the best historical and other engravers were employed, each to engrave a vignette; each vignette to occupy 4 square inches, and each artist to expend 6 months on his vignette: let these 20 vignettes be transferred to two steel plates, one for the front of the note, and the other for the back; the result will be, that one man (could such an one be found) would be occupied 10 years, or 20 men 6 months, to produce a note of equal goodness. Is it possible to suppose any thing better can be adopted, than to make it unprofitable to be engaged in such business? If a bank note plate can be made to cost 10,000*l.* (which would be the case, if 20 artists, whose time would be worth 1,000*l.* per annum, were engaged 6 months each), would it not be much less likely to be imitated than one that would cost but 5 or 10*l.*? If a bank plate

can be made to contain the work of 20 of the best artists in the world, could another plate of equal goodness be made without employing the same artists? It is hardly to be presumed that 20 such artists would be engaged in making a spurious note; but admitting it possible, it would not be a fac-simile, and might be easily distinguished from the true note, by any one acquainted with the original. One of the peculiar features of this invention is, that any one may be furnished with a perfect fac-simile of the whole or of any part of the original note; which will serve to identify the note if good: this is owing to the infinite number of impressions that may be obtained from the original engraving. Having shown that a plate may be made to cost 10,000*l.*, we will undertake to prove that it is not incompatible with economy. To show the economy of this plan in its best light, we must be allowed to apply it to the best advantage, which would be by its being adopted by a bank whose daily consumption is not less than 25,000 notes.

Suppose the first steel plate costs 10,000*l.*, the next 999 plates will only cost 10,000*l.*: then 1,000 steel plates will amount to 20,000*l.* Each steel plate will print at least 150,000 impressions; of course 1,000 plates would furnish 150,000,000 of impressions, which is the number that would be wanted in 20 years, at 25,000 impressions per day. Now, the cost of impressions from steel plates would be (where the above number is wanted) one penny for 31¼ impressions; whereas, if copper plates were used, which cost only 3*l.* each plate, the number of impressions for a penny would be but 8⅓, since a copper plate prints but 6,000 impressions before it is worn out.

Another very important consideration is, that steel plates admit of an improved method of printing, and when worked to the greatest advantage, will make a saving of 50 per cent; this saving, in 20 years, in printing the

above number of notes would be 75,000*l.* which would not only pay the whole cost of making the plates, but leave a balance of 55,000*l.*

This system of making plates and of printing, will apply equally well to that of ornamenting standard works, particularly bibles, prayer books, primers, catechisms, spelling books, natural history, and philosophy. In proportion to the number wanted, will be the advantage of adopting this plan. It is often the case in this country, that from 4 to 6 copper plates are worn out in one edition, and not half the impressions perfect. A hardened steel plate will print more *proof impressions* than the above number of copper plates can furnish, even of common impressions. This fact is demonstrated by the plates Nos. XXXIX and XL, accompanying this communication. The impressions from plate No. XXXIX, are of the first impressions taken from the plate. The impressions, plate No. XL, were taken after 35,000 impressions had been taken from it.

This plate will also show the practicability of identity. The four medallions by inspection will be found to be perfectly the same, *line for line and dot for dot.* By examining the machine engraving, particularly the chain; the two *styles* of work, viz. copper plate and letter-press printing will be seen beautifully combined. This is effected by the process of transferring and re-transferring. This kind of engraving is extremely difficult to imitate. This machine, which is denominated the geometrical lathe, was invented in America by Mr. Asa Spencer. Its powers for producing variety are equalled only by the kaleidoscope; but for beautiful patterns it surpasses every thing of the kind. It has one of the peculiarities of the kaleidoscope, viz. that the turning of a screw, like the turning of the kaleidoscope, produces an entire new pattern, which was never before seen, and perhaps would never be seen again.

This pattern however may be perpetuated by the transferring process. We are now printing from a plate of the most delicate work, which has already printed above 100,000 impressions, and is yet sound. We cannot yet say, how long a well hardened steel plate will last, having never printed more than 500,000 impressions from the same plate: it should however, be observed, that this plate consisted principally of writing, or work quite as strong. It may also be observed, that the impressions are yet good. The manufacture of printed calicoes, ribbons, &c., as well as of earthenware, may be much improved by adopting this system; and we are happy to say that experiments are soon to be made thereof. This improvement in engraving will apply to about one quarter of the present number of plates used. The others must necessarily be of copper, as a sufficient number of impressions would not be wanted to defray the expense of a steel plate. Not less than a number of impressions which would wear out three copper plates would warrant the making a steel plate. But such is the number of subjects to which this art will apply, and the great inducement to publishers to embellish their works, where large editions are wanted, which they now can do in consequence of its economy, that instead of the demand of engravers being lessened, it will be very much enhanced.

The use of fine and delicate engraving for Bank notes, has been objected to, in consequence of the difficulty of printing on such highly sized paper. But this objection is entirely got over by our method of printing in the water leaf, and sizing after printing. This improvement has a triple advantage,—that of producing beautiful impressions, having on its surface, after printing, a better size, and preventing the ink from being so easily transferred.

In order to describe the method of preparing and

hardening the steel plate and dies, the following particulars are necessary:

In order to decarbonate the surfaces of cast steel plates, cylinders, or dies, by which they are rendered much softer and fitter for receiving either transferred or engraved designs, we use pure iron filings, divested of all foreign or extraneous matters.

The stratum of decarbonated steel should not be too thick for transferring fine and delicate engravings; for instance, not more than three times the depth of the engraving: but for other purposes the surface of the steel may be decarbonated to any required thickness.

To decarbonate it to a proper thickness for fine engravings, it is to be exposed for four hours in a white heat, inclosed in a cast iron box, with a well closed lid. The sides of the cast iron box are made at least three quarters of an inch in thickness; and at least a thickness of half an inch of pure iron filings should cover or surround the cast steel surface to be decarbonated. The box is to be suffered to cool very slowly, which may be effected by shutting off all access of air to the furnace, and covering it with a layer six or seven inches in thickness, of fine cinders. Each side of the steel plate, cylinder, or die, must be equally decarbonated, to prevent it from springing or warping in hardening. It is also found that the safest way to heat the plates, cylinders, or dies, is by placing them in a vertical position.

The best cast steel is preferred to any other sort of steel for the purpose of making plates, cylinders, circular or other dies; and more especially, when such plates, cylinders, or dies are intended to be decarbonated. For the reason given above, the steel is decarbonated, solely for the purpose of rendering it sufficiently soft for receiving any impression intended to be made thereon; it is therefore necessary that, after any piece of steel has been

so decarbonated, whether it be in the shape of a plate, or a cylinder, or a die, it should, previously to being printed from, be again carbonated, or re-converted into steel capable of being hardened. In order, therefore, to effect this carbonization or re-conversion into steel, the following process is employed:—a suitable quantity of leather is to be converted into charcoal by the well-known method of exposing it to a red heat in an iron retort, for a sufficient length of time; or, until most of the evaporable matter is driven off the leather. Having thus prepared the charcoal, it is reduced to a very fine powder; then take a box made of cast iron, of sufficient dimensions to receive the plate, cylinder, or die, which is to be re-converted into steel, so as that the intermediate space between the sides of the said box, and the plate, cylinder, or die, may be about one inch. This box is to be filled with the powdered charcoal, and having covered it with a well fitted lid, let it be placed in a furnace similar to those used for melting brass, when the heat must be gradually increased, until the box is somewhat above a red heat; it must be suffered to remain in that state till all the evaporable matter is driven off from the charcoal. Then remove the lid from the box, and immerse the plate, cylinder, or die, into the powdered charcoal; taking care to place it as nearly in the middle as possible, so that it may be surrounded on all sides by a stratum of the powder, of nearly an uniform thickness. The lid being replaced, the box, with the plate, cylinder, or die, must remain in the degree of heat before described, for from three to five hours, according to the thickness of the plate, cylinder, or die so exposed. Three hours are sufficient for a plate of half an inch in thickness; and five hours when the steel is one inch and a half in thickness. After the plate, cylinder, or die has been thus exposed to the fire for a sufficient length of time, take it from the

box and immediately plunge it into cold water. It is important here to observe, that it is found by experience that the plates or other pieces of steel when plunged into cold water, are least liable to be warped or bent when they are held in a vertical position, or made to enter the water in the direction of their length. If a piece of steel, heated to a proper degree for hardening, be plunged into water, and suffered to remain there until it becomes cold, it is found by experience to be very liable to crack or break; and, in many cases, it would be found too hard for the operations it was intended to perform. If the steel cracks or breaks, it is spoiled. In order to render it fit for use, should it happen not to be broken in the hardening, it is the common practice to heat the steel again, in order to reduce or lower its temper, as it is technically called. The degree of heat to which it is now exposed determines the future degree of hardness, or the temper, and this is indicated by a change of colour upon the surface of the steel. During this heating a succession of shades is produced from a very pale straw colour to a deep blue. It is found, however, by long experience, that on plunging the heated steel into cold water, and suffering it to remain there no longer than is sufficient for lowering the temperature of the steel to the same degree as that to which a hard piece of steel must have been raised, in order to temper it in the common way; it not only produces the same degree of hardness in the steel, but, what is of much more importance, almost entirely does away the risk or liability of its cracking or breaking. It is impossible to communicate by words, or to describe the criterion by which we can judge of, or determine, when the steel has arrived at the proper degree of temperature, after being plunged into cold water; it can only be learned by actual observation, as the workman must be guided entirely by the kind of hissing or singing noise,

which the heated steel produces in the water while cooling. From the moment of its being first plunged into the water, a varying sound will be observed; and it is at a certain tone before the noise ceases, that the effect to be produced is known. The only directions which can be given, whereby the experimentalist can be benefitted, are as follow: namely, to take a piece of steel which has already been hardened by remaining in the water till cold; and, by the common method of again heating it, to let it be brought to the pale yellow, or straw colour, which indicates the desired temper of the steel plate to be hardened by the above process; as soon as he discovers this colour to be produced, to dip the steel into water and attend carefully to the hissing, or, as some call it, singing noise, which it occasions; he will then be better able, and with fewer experiments, to judge of the precise time at which the steel should be taken out. It is not meant to be understood that the temper indicated by a straw colour, is that to which the steel plate, cylinder, or die, should be ultimately reduced; because it would then be found too hard; but merely that the temperature which would produce that colour, is that by which the peculiar sound would be occasioned when the steel should be withdrawn from the water for the first time. Immediately on withdrawing it from the water, the steel plate, cylinder, or die, must be laid upon, or held over a fire, and heated uniformly, until its temperature is raised to that degree at which tallow would be decomposed; or, in other words, until smoke is perceived to arise from the surface of the steel plate, cylinder, or die, after having been rubbed with tallow. The steel plate, cylinder, or die, must then be again plunged into water, and kept there until the sound becomes somewhat weaker than before. It is then to be taken out, and heated a second time to the same degree, by the same rule of smoking tallow as before; and

the third time plunged into water, till the sound becomes again weaker than the last. Expose it a third time to the fire as before; and, for the last time, return it into the water and cool it; after it is cooled, clean the surface of the steel plate, cylinder, or die; and by heating it over the fire, the temper must be finally reduced by bringing on a brown, or such other lighter or darker shade of colour, as may best suit the quality of the steel, or the purpose to which it is to be applied.

PERKINS, FAIRMAN & HEATH.
STEREOGRAPHIC.
Hardened Steel Plate

Second Impression.

PAPERS

IN

MECHANICS.

N° I.

IMPROVED SERVICE PIPE FOR CISTERNS.

The sum of FIVE GUINEAS *was this Session presented to Mr.* WM. BULLOCK, *Star Court, Compton Street, Soho, for an* IMPROVED SERVICE PIPE FOR CISTERNS. *The following communication has been received from him on the subject, and one of the Instruments is placed in the Society's Repository.*

3, Star Court, Compton Street,
Soho, March 29, 1820.

SIR;

I HEREWITH send for the judgment of the Society of Arts, &c., an improved water service for cisterns, in which the floating ball, instead of being attached to a stop cock, as is the usual practice, is made to open and shut a valve of very simple construction. By the substitution of a valve instead of a stop cock the waste of water and accidents arising from the stiffness and corrosion of the latter are entirely avoided, and a much freer passage is allowed to the water.

The inspection of the instrument will at once explain its construction and mode of action.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. WILLIAM BULLOCK.

Reference to the Engraving of Mr. BULLOCK'S *Ball Valve for Cisterns*, Plate I.

Fig. 4 is a view of the entire instrument tapering at its upper extremity, by which it is inserted into the service main. A fulcrum is formed by a bent arm projecting from the outside of the orifice through which the water is discharged; and upon this fulcrum the rod or lever of the floating ball traverses by means of two swivels or points (shown particularly in fig. 8), which work in two shallow holes, one on each side of the fulcrum. The extremity of the short arm of the lever raises the valve up, and thus allows the discharge of the water into the cistern. When the cistern is sufficiently filled to float the ball, the lever ceases to press the valve up: in proportion as the ball rises, the valve descends, and when the rod has reached the position represented by the dotted lines, it ceases to be in contact with the valve, and of course this latter closes the discharging pipe, and is retained in its position both by its own weight, and by the pressure of the water in the main.

Fig. 5 is a section showing more particularly the figure of the valve and its situation.

Fig. 7 shows the orifice of the discharging pipe, with the ring in its center, within which the stem of the valve works, and which prevents the valve from being displaced.

Fig. 6 is a view at right angles to fig. 4, showing particularly the form of the end of the bent arm, which serves as the fulcrum to the lever.

N° II.

STRIKING PART OF A CLOCK.

The large SILVER MEDAL *of the Society and* TWENTY GUINEAS *were this Session voted to Mr.* JOHN PRIOR, *of Nessfield, near Skipton, for the* STRIKING PART OF A CLOCK. *The following communication has been received from the candidate, and a Model of his Invention is placed in the Society's Repository.*

Nessfield, near Skipton,
December 18, 1819.

SIR;

I BEG you will have the goodness to lay the accompanying model of the striking part of a Clock before the Society of Arts, &c. &c., for their inspection and decision. Its construction is so obvious that I need not say much on that subject, as the Committee will perceive the mechanism of it at first sight.

Before this machine is put in action, it should be set upright, in which position the pendulum, or, which is the same thing, the hammer, when at rest will hang in a line with the pedestal. This being properly adjusted, wind upon the barrel the cord which bears the weight, and disengage the detent, when the pendulum will strike the hour on the bell.

This apparatus may be connected in the usual way with

the train of a clock, or it may be adapted to a common watch in the following manner:—

Take off the outer case of the watch, if it has any; throw back the glass, and lay the watch with the face upwards upon the circular plate of brass fixed in front of the instrument, and which may be raised or lowered according to the thickness of the watch. The watch being in this position, and having the axis of its minute hand concentric with the vertical axis of the machine, which carries a plate with 60 divisions, screw the sliders fast which inclose the watch. Then raise or lower the plate on which the watch rests till the notch of ivory embraces the minute hand, and screw it fast in this position. Lastly, hold the upright axis firmly with one hand, and with the other turn the minute plate till the divisions on it coincide with those on the face of the watch. The machine will now strike the hours according as they are indicated by the watch.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. JOHN PRIOR.

Reference to the Engraving of Mr. JOHN PRIOR'S *striking part of a Clock,* Plate II.

Fig. 1 is a side view, and Fig. 2 a bird's-eye view of the machine: *a*, the weight; *b*, the barrel on the axis of the escape wheel; *c*, the ratchet wheel; *d*, the escape wheel of 78 teeth, this is also the count wheel, the pins being in the rim as at *e e*; *f*, the pallets; *g* and *h*, the pendulum rod and ball, which is also the hammer; *i*, the bell, placed oblique enough to let the hammer clear it on one side, and only strike it on the other; *k*, the detent; this detent is raised by the spring *l l* striking against the slope stud *m*,

of the detent arm; fig. 3 shows the spring *l* separate; it has an arm *n*, projecting through the plate *p p*; the snail *q* in every turn presses against this arm, and raises the spring, as shown by the dotted lines, and, on the snail passing, the spring *l*, aided by its weight *r*, strikes beyond its place of rest, and by the tooth *o*, fig. 4, raises the detent stud *m*; *s* is a pin to keep it from rising too high; *t* is a guide pin fixed in the plate *p p*, and standing through the forked end of the spring *l*; *v* is a minute plate fixed under the snail *q*, and moving stiffly on the axis *w* by means of a spring fixed below it; on this axis is fixed a short hollow cylinder of ivory *x*, with a notch in it; *y*, fig. 2, is an index by which the minute plate is set to the same time as the watch which is to be secured in the watch-holder *z z*, in such a manner that the axis of the minute hand is under the axis *w*; then raise the watch-holder till the minute hand goes into the notch of the cylinder *x*, and fix it by the screw 1: the minute hand will then carry round the snail *q*, and thereby strike the hours: 2 is the counter string to wind it up; 3 an additional ball which may be screwed on the top of the pendulum to make it strike slower.

N° III.

IMPROVED METHOD OF CONSTRUCTING ROOFS.

The large SILVER MEDAL *of the Society was this Session voted to* A. H. HOLDSWORTH, *Esq., of Dartmouth, for an* IMPROVED METHOD OF CONSTRUCTING ROOFS. *The following communication has been received on the subject, and Models of the Invention are placed in the Society's Repository.*

15, Manchester Buildings, Westminster Bridge,
SIR; April 26, 1820.

THE two models which I send herewith to the Society of Arts, &c. for their inspection, are of the timbers of a roof which covers a building one hundred feet long by thirty-seven feet wide; and as the whole was constructed under my direction, and appears to possess many advantages over the usual method of framing roofs, I am desirous of submitting them to the judgment of the Society, in order that (if approved) they may be offered to the acceptance of the public through the medium of the Transactions of the Society.

The advantages which this method affords are the saving of a considerable proportion of the timber usually employed, and the gaining for useful purposes the whole space that is contained within the roof.

I have also constructed for a friend a roof of the same kind placed over his dwelling house, so that, with walls

only six feet above his upper floor, he gets high rooms, whilst on the outside his house appears very low: his barns, haylofts, &c., are built on the same plan.

The mode in which I have constructed these roofs is as follows: A A, Plate III, fig. 1, being the walls of the house, and B one of the timbers of the uppermost floor, resting on sleepers *f f*, let into the wall, I fix two pieces of wood D D, on the top of the wall, resting also on sleepers *f f*. The principals C C, forming each pair, are then secured at the bottom into the pieces D D, and are fastened to each other at the top by iron pins. Each pair of principals is supported by two arch pieces E E; these pieces are *in their grain*, and are formed on the plan recommended by Mr. Hookey of the King's-yard at Woolwich, to whom the country is so much indebted for this method of converting timber. They are cut lengthways by a saw into three pieces, to within two feet of one end, are then placed in a steam kiln, and boiled until they will bend freely, when they are fixed to a mould and left to cool, after which a few pins of wood are driven through them to keep the pieces so cut from again flying open. The arch pieces will get a little out of place when taken from the mould, but will easily be brought back, and when secured under the principals, will fit the more firmly.

These arch pieces are let by their lower end into the beam B, of the floor, and are thus firmly pinned, while at the top they cross one another, and each butts against its opposite principal. They are also secured by iron straps to the short pieces D D, on which the principals rest, which latter are thus prevented from sinking and thrusting out the walls, and the whole makes a stiff and compleat framing, on which the longitudinal rafters *h h*, and the transverse pieces *g g*, are fastened in the usual manner. In the middle of the building, where four principals and as many arch pieces meet, and consequently cannot

cross each other as in fig. 1, I have inserted a kind of king-post in which the ends are secured, fig. 2.

In a common hayloft, or cottage, the same advantages may be obtained, by letting the principals rest on short pieces of wood, which may, as before described, be attached by a strap of iron to another piece going from the beams of the floor to the middle of the principal immediately under the couple beam, where it may be secured. It may be made of straight timber; but in the country, where there is always crooked timber enough about a farm, of no use for house work, this will be employed to greater advantage, as it will save what is of more value to the carpenter, and at the same time will give more space in the room.

It should be observed that roofs over barns or other buildings which have only a ground floor may be constructed in the same way, care being always taken to bring the feet of the arch-pieces so far down the wall as to give them a firm bearing.

The principals of the roof represented by one of the accompanying models are forty feet long, and those which stand angularly in the middle of the building are fifty-six feet long; and from the complete success of this experiment, I should not hesitate to apply the same principle to a roof of any given span for which timber of sufficient length could be procured.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. A. H. Holdsworth.

N° IV.

BED-STONE OF A CORN MILL.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* T. AUSTEN, *of Waltham Abbey Mills, for his improved method of supporting and adjusting the* BED-STONE OF A CORN MILL.

The following communications have been received on the subject, and a Model of the Invention is placed in the Society's Repository.

Waltham Abbey,
April 14th, 1819.

SIR;

I BEG leave to submit to the consideration of the Society of Arts, &c., an improvement in the mode of adjustment of the Bed-stone of a Corn Mill.

The methods hitherto adopted, are attended with much practical difficulty, and loss both of time and of produce, it being particularly requisite that all bed-stones of corn mills should be kept perfectly level and firm on their bearings, in order to obtain a good quality of flour.

To obviate this difficulty, I have adopted an improvement in a mill belonging to the Honourable Board of Ordnance, at Waltham Abbey, which is found to answer every intended purpose, uniting to simplicity of construction, accuracy of adjustment.

The model accompanying this, will show the principle of my improvement.

The bed-stone is fixed fast in a strong cast iron frame, bedded in plaster of paris, and is of one uniform strength.

The bottom frame is of cast iron, with three screws in the bottom part placed on the plan of a triangle, for the top frame with the bed-stone to lie on; it is always firm and easily adjusted, which is not the case in the mode generally adopted wherein wedges are used.

The four screws in the sides of the bottom frame, are to adjust the bed-stone horizontally.

Trusting this will meet the approbation of the Society,

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. THOMAS AUSTEN.

CERTIFICATES.

Waltham Abbey,
April 14th, 1819.

WE, the undersigned do hereby certify, that the principle adopted by Mr. Thomas Austen, of Waltham Abbey, in the county of Essex, for the purpose of adjusting the bed-stone of a corn mill so that it will lie firm on its bearings, fully answers the intended purpose, upon a trial of two years at the Waltham Abbey corn mill, and is evidently a public benefit, as it produces more flour and less weight of offal from a given quantity of wheat than the mode heretofore in general use, of wedging the bed-stone up.

JOHN BY, *Major Company Royal Engineers.*
WILLIAM DRAYSON, *Clerk of the Works.*
GEORGE BARNES, *Clerk.*
JOHN KILLICK, *Hackney* } *Proprietors of Lea-bridge*
JOHN KILLICK, *Jun.* ... } *Corn mills.*

A. Aikin, Esq.
Secretary, &c. &c.

Harlow, Essex,
Oct. 29th, 1819.

HAVING examined the cast iron curbs for the stones put into Waltham Abbey mills, by Mr. Austen, I hereby certify them to be constructed upon a principle far superior to any I have yet seen, both with respect to the facility of adjusting the bed-stone, and the equality of support which they render to the back and skirt of it in all its parts; and so far am I convinced of their utility, that I have introduced them into a new water corn mill, which I am now erecting, with four pair of stones, as they completely obviate the difficulty which, in the course of my practice, I have frequently experienced in levelling the bed-stone correctly, and at the same time to give the teeth of the stone pinion the proper hold in those of the spur wheel.

WILLIAM REDINGTON, *Millwright.*

Greenwich,
May 25th, 1819.

SIR;

I HAVE examined your method of laying and adjusting the lower or bed-stones, in corn mills, and am of opinion that it may be applied with great advantage to mills in general (particularly where the framing is weak), as the levelling may be performed in a very short time by any miller, with only the assistance of a level; and when it is considered of what importance to the miller it is, that the stones should be kept level, the advantage of the above method will be very evident.

I am, Sir,
&c. &c. &c.

To Mr. Austen. J. PENN, *Millwright.*

Mill-place, Greenwich,
Nov. 11th, 1819.

SIR;

THE bed-stones of a corn mill at present under my direction having been out of an horizontal position, great inconvenience has been experienced, and much labour requisite to render them horizontal by means of wedges, which are often displaced and are troublesome to adjust.

Mr. Thomas Austen, of Waltham Abbey, has this day called upon me and explained his method of effecting this purpose by three adjusting screws, &c., which appears so easily and precisely to answer every purpose of obtaining a perfectly horizontal position, that I shall advise the immediate adoption of his plan.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. WILLIAM COOKE.

Reference to the Engraving of Mr. THOMAS AUSTEN'S *method of laying and adjusting the Bed-Stone of a Corn Mill,* Plate IV.

Fig. 1, a section through the mill stones and the floor; *a,* the bed-stone fixed in a cast iron case; *b b b b,* the bed of cast iron; *c c,* two of the three adjusting screws on the points of which the stone rests; *d d d d* (figs. 2, 3), four screws to adjust the stone sideways; *e e,* two beams on which the floor and cast iron bed rests, the ends *b b* being let in level with the surface; *f f,* joists; *g g,* the floor; *h h,* a raised flat circle of wood to cover the adjusting screws and bed, close to the stone; *i i,* bolts which fasten it down; *k k,* the case which incloses the stones; *l,* the hopper; *m,* the shoe; *n,* the damsel; *o,* the upper stone, which is turned by the axis *p*.

Fig. 2, a bird's eye view of the bed-stone and cast iron bed, resting on the beams *e e*; fig. 3, the under side of the cast iron bed and stone.

Fig. 4, a perspective view of the stone in a simple iron bed adapted to lay on an old floor; it is cast without the arms *b b b b*, as shown in the other figure.

Fig. 5, a larger section of the cast iron box, in which the axis *p* turns; *q*, a metal collar which keeps the grain from the axis; the upper part *r*, of the axis *p*, is octagonal, to fit the octagonal hole of the iron box *s*, to the pin *t*, on which the upper stone *o* hangs; fig. 6 shows a side view, and fig. 7 a bird's eye view of the iron bar which is fixed in the upper stone; *v v*, cross arms which drop into the cross of the box *s*, fig. 8: these cross arms are shaped like a gothic arch, as shown in fig. 6; the box *s*, on the axis *p*, gives motion to this bar, and, by means of it, carries round the upper stone; fig. 9, a side view of the box *s*, showing the notch for the bar, fig. 6, and the bottom part of the damsel *w*, which it turns.

Fig. 1 is drawn to $\frac{1}{2}$ inch to one foot; figs. 2 and 3, $\frac{1}{4}$ inch to a foot; figs. 5 to 9, 1 inch to a foot.

N° V.

DOUBLE-DOOR SPRING.

The sum of FIVE GUINEAS *was this Session given to Mr.* JAMES WHITE, *of Laystall Street, for a* DOUBLE-DOOR SPRING. *The following communication has been received from the candidate on the subject, and one of the Instruments is placed in the Society's Repository.*

Laystall Street,
Nov. 17th, 1819.

SIR;

I BEG leave to submit to the Society of Arts, &c., the accompanying model of a Double-door Spring, which may be fixed either at the top or bottom of the door, and is so contrived that the power of the spring is the greatest when the door is shut. It is not liable to get out of repair, and the expense is moderate, not exceeding about twenty-two shillings.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JAMES WHITE.

On referring to the last volume (the 37th) of the transactions of the Society, page 102, will be found the description and figure of a Double-door Spring, by the same Mr. White.

The intention and general principle of each instrument are the same, but the arrangement of the parts being in

the opinion of the Society more compact and efficacious in the present, than in the former instrument, and the object itself being of considerable importance, it has been thought advisable to lay before the public a representation of the instrument in its improved state.

Reference to the Engraving of Mr. JAMES WHITE'S *Double-Door Spring,* Plate V.

Fig. 1, the dotted lines *a a* show part of the door shut; *b,* the center on which the door turns; *c,* an arm carrying a friction roller (*d,* fig. 3); *e e,* two levers on which the spring *f f* acts, and thereby holds the door shut; *g,* a stop which prevents the levers being pushed farther than to shut the door. When the door is shut, the spring *f* acts with half its power on the arm *c,* at full length, but when the door is open as fig. 2, it acts with about one sixth of its power on the arm *c,* in a direction which reduces its effect on the door also about one-sixth, whereby the action on the door when open, is one eighteenth of the power which holds it shut; but admitting the strength of the spring to have increased by one half, there then remains a reduction of power equal to one-twelfth of the original quantity. These numbers, however, depend on the proportion of the levers, and on the part where the spring acts.

In figs. 1 and 2, the upper plate by which it is screwed to the floor is removed to show the parts; its place is shown by the dotted lines and holes *h h h h.*

Fig. 3, a section of the box; *a a,* part of the door shut; *i i,* a brass shoe screwed on the door; the center *b* is fitted into a square hole, and secured by a screw nut *k*; *l,* a screw which hooks on to the spring *f,* to regulate its power by turning the nut *m.*

N° VI.

IMPROVED UMBRELLA JOINT.

The smaller or VULCAN SILVER MEDAL *and* FIVE GUINEAS *were this Session given to Mr.* JOHN SMITH, *Newcastle Street, Fleet Market, for an* IMPROVED UMBRELLA JOINT. *The following communication has been received from the candidate, and one of his Umbrellas is placed in the Repository of the Society.*

Newcastle Street, Fleet Market,
Dec. 21, 1819.

SIR;

I BEG to submit to the Society for the Encouragement of Arts, &c., an Umbrella Frame that possesses a new and better method of attaching the stretchers to the ribs than any now in use. By means of this improvement, the rib and stretcher are allowed to lie close to the stick when the umbrella is closed, thus taking up less room than a common umbrella of equal size; additional strength is given to the ribs, and the cover is not liable to be fretted at the junction of the rib and stretcher, an accident that perpetually occurs sooner or later with umbrellas of the common construction.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JOHN SMITH.

Reference to the Engraving of Mr. SMITH'S *Umbrella Joint*, Plate V.

Fig. 4, a side view; *n n*, part of the rib, made of whale-bone; *o*, the stretcher, of brass; *p*, the connecting piece, also of brass.

Fig. 5, a front view; fig. 6, a section showing the cut which is made into the whale-bone by means of a circular cutter; *p*, a double convex piece, stamped out of plate brass, and of exactly the same curve and thickness as the cutter, so that it correctly fills the cut in the whale-bone, and is secured in its place by a rivet.

The figures are drawn of half the real size.

N° VII.

MACHINE FOR SWEEPING CHIMNIES.

The lesser or VULCAN SILVER MEDAL *and* TEN GUINEAS *were this Session voted to Mr.* J. SKINNER, *Dean Street, Holborn, for a* MACHINE FOR SWEEPING CHIMNIES. *The following communication has been received from the candidate, and the Machine is placed in the Society's Repository.*

Dean Street, Holborn,
April 4th, 1820.

SIR;

I REQUEST that you will have the goodness to lay before the Society of Arts, &c., the head of a Chimney-Sweeping Machine of my invention. It has answered satisfactorily in the trials that I have made, or have caused to be made of it, and appears to avoid most of the imperfec-

tions which, in the common ascending chimney-sweeping machines, are too often the occasion of much loss of time, embarrassment, and imperfect work. It is impossible to clean effectually a flue, the diameter of which is irregular and varying, unless the brushes are fixed on springs which will force the machine to occupy the entire width of the flue. In general this effect is aimed at, and is attained to a certain degree by the use of whalebone; but this substance is so much affected in its elasticity by the weather, and is so likely to be permanently warped when introduced into a chimney the soot of which is on fire, that much of the repugnance to the employment of machines instead of climbing boys, is to be attributed to this circumstance. I have therefore made the springs in my machine of steel, which, although it enhances the prime cost, will not be found in the end to be more expensive, and at the same time they are both more powerful and certain in their operation. The construction of the machine allows it to pass through a flue nine inches in diameter, and enables it also to fill a flue twenty inches in diameter. In the latter situation there are vacant spaces about the center of the machine which allow the soot to fall in proportion as it is detached from the sides by the action of the brushes; hence its ascent up foul chimnies is greatly facilitated. The machine itself accompanies this letter, and I shall be happy to attend the Committee when required, for the purpose of giving any farther explanation.

The cost of the machine, exclusive of rods, is from thirty to forty shillings.

I am, Sir,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.

JAMES SKINNER.

Reference to the Engraving of Mr. JAMES SKINNER'S *Machine for Sweeping Chimnies,* Plate VI.

Fig. 1, the machine expanded, composed of eight square brushes mounted on steel springs; the four upper springs are screwed fast at *a, b, c,* and *d,* to the sloping ends of the wooden cross piece *d,* and the four lower springs are screwed in the same way to the bottom at *e, f, g,* and *h,* so as to alternate with the upper ones; and when pressed close by the sides of the chimney, they lie together, as fig. 2; *i, k, l, m,* and *n, o, p, q,* are eight guide springs (or straps), made of iron, by which the brushes can be closed in moving either way without catching against protuberances; these guide springs have holes in their bent ends, by which they slide on the guide wires, *r r r r,* and *s s s s;* *t* and *v* are two cross pieces to support the guide wires; one is shown separate at fig. 3; the bent ends of the guide wires are inserted in the eyes *u u u u;* fig. 4 shows one of the guide springs *o* and wire *s,* separate; *w,* a rolling ball to lessen friction; *x,* the joint at which it is connected to the other sticks; wire staples are fixed in the end of each brush, shown at *z z z,* fig. 2, to form the joint with the folded end of the guide springs, shown at *y,* fig. 4.

N° VIII.

SPRING BANDAGE.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* J. GORMAN, *Fellow of the Royal College of Surgeons, for a* SPRING BANDAGE OR TRUSS, *in order to support and compress the abdominal viscera. The following communication has been received from the candidate, and one of his Machines has been placed in the Society's Repository.*

Spanish Place, Manchester Square,
January 7th, 1820.

SIR;

I BEG leave through you to submit to the Society of Arts, a machine which I have invented, for the support of spinal and abdominal weakness.

This band, or machine, consists of five pieces of elastic steel, two for the abdomen, one for the spine, and two surrounding springs; the two surrounding springs are joined to the center of the spinal plate by means of screws, and in like manner to the abdominal plates, and these two unite by means of straps and buckles.

This band can be made to suit all ages, sizes and shapes; and is applicable to all cases of spinal weakness, where the bones are not absolutely carious.

To those persons who are inclined to corpulency, this band will perhaps be most useful; there is no pressure on the hips, loins, nor ribs, while from its peculiar

mechanism, it is calculated to reduce the most corpulent habits. Its application can never be attended with bad effects, like the belts that are generally worn, which divide as it were the viscera into two portions, and by producing general pressure, almost always impede the secretion of the kidneys.

This band, on the contrary, accommodates itself to the exact form of the body (which form is not altogether circular), throwing the pressure on the spine and abdomen, leaving the loins and kidneys perfectly free, and by gently pressing the viscera inwards and upwards, greatly diminishes the risk of hernia or rupture.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. J. GORMAN, *Member of the Royal College of Surgeons, in London, &c. &c.*

Explanation of the Engraving of Mr. GORMAN'S *Bandage,* Plate VI.

Fig. 7 represents the steel springs and plates of which Mr. Gorman's bandage is composed, and which, when in use, are covered and properly padded to prevent any painful pressure or excoriation. The square plate is that which is applied to the spine; the two semi-circular ones are those which support the abdomen; these latter are drawn as near to each other as the ease of the patient will admit, by means of strings fixed to the cover, which may be made of calico or any other suitable material.

N° IX.

IMPROVED CONSTRUCTION OF ANVILS.

The smaller, or VULCAN SILVER MEDAL *and* FIVE GUINEAS *were this Session voted to Mr.* RICHARD KING, *of Thames Street, Bankside, for his improvement in the* CONSTRUCTION OF ANVILS. *The following communication has been received from the Candidate, and Models of the Invention have been placed in the Repository of the Society.*

8, Thames Street, Bankside,
22nd March, 1820.

SIR;

HAVING long experienced the difficulty attending the making of sound Anvils (used by smiths in all departments of the trade) by the present system, and the frequency with which the quarters and beak irons break off, I am induced to request that you will please to lay before the Society for the Encouragement of Arts, Manufactures, and Commerce, the model of an improvement suggested by me, in the manufacture of that article, which will obviate the frequent occurrence of breaking in those manufactured in the common way; and of which I also send a model, to show more clearly the nature of my improvement.

If the Society should be pleased to consider it worthy their countenance and support, I shall feel myself ho-

noured, and will attend to explain whenever they may be pleased to take it into consideration.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. RICHARD KING.

The usual way of making large anvils is, first to forge a nearly cubic mass for the body of the anvil, and then to unite the beak and quarter with this block, by means of plain *vertical* surfaces, secured by welding. The feet are also welded on in the same manner. The face is made of steel, and is laid on the top of the body of the anvil and of the quarter. The several parts above mentioned are shown in Plate VI, fig. 5. It is obviously, however, impossible, on this construction, that the welding should be effectual for more than an inch or two from the external line of junction: hence a succession of heavy blows on the face of the anvil will necessarily sooner or later cause these vertical joints (especially of the beak and quarter) to give way.

Mr. King follows a very different process. He forges the body as well as the beak and quarter of one piece of iron, and the foot or support of another; these are united by means of a *horizontal* plane, joint and welding, as shown fig. 6, from which it is manifest that the usual causes of the destruction of anvils are avoided, with the farther advantage of increased simplicity in the manufacture.

Nos X and XI.

WARMING AND VENTILATING ROOMS, AND VENTILATING THE HOLDS OF SHIPS.

The large Silver Medal *of the Society was this Session voted to Mr.* Jacob Perkins, *of London, for his* Methods of warming and ventilating Rooms, and of ventilating the Holds of Ships. *The following communications have been received from the Candidate on the subject.*

Austin Friars,
March 28, 1820.

SIR;

I request that you will have the goodness to lay before the Society of Arts, &c., the accompanying papers and drawings, descriptive of a method which has been practised by me with perfect success, of ventilating and warming apartments and workshops; and also a method of ventilating the holds of ships.

I am, Sir,
&c. &c. &c.
Jacob Perkins.

A. Aikin, Esq.,
Secretary, &c. &c.

A method of Warming and Ventilating Apartments and Warehouses.

This improvement consists simply in introducing a large column of cold air immediately at the back of

large column of cold air immediately at the back of the stove, by which means the radiant heat from the stove is rapidly carried off. The greater the quantity of air which is made to strike against, and pass by the stove, the greater is the quantity of heat given out by it. This kind of stove will not work to good advantage when the room is air-tight: to remedy this evil, an aperture should be made near the ceiling. But where there is a chimney draft in the room, opposite the stove, or in the next or third room from the stove, the effect is very much increased, especially if a small fire is kept up in the chimney of that room. This constant current of warm air ventilates the rooms perfectly, and renders them pleasant and wholesome. It has also been found, that the air is very much improved by having a vessel of water placed on the top of the stove, so that evaporation may be constantly going on.

Reference to the Engraving of Mr. PERKINS' *Apparatus*, Plate VII.

Fig. 1, front view of the stove.

Fig. 2, side view of ditto.

Fig. 3, plan of ditto.

a a a, the body of the stove.

b b b, a sheet of iron affixed to the air conductor, and embracing $\frac{3}{4}$ the diameter of the stove, and extending from top to bottom, leaving a space of two inches between it and the stove.

c c c, the air conductor, being about the same diameter as the stove. It is also attached to the sheet of iron *b*.

d, the wall into which the air conductor is fixed.

e e e, a cup to be supplied with water from time to time, as the former portion evaporates.

A method of Ventilating the Holds of Ships.

Plate VIII, fig. 1, a plan of part of a ship, showing a ventilator placed diagonally across it.

Fig. 2, section of a ventilator.

a a, tanks, or water butts.

b b, hose for conducting the foul air *into* the tanks.

c c, hose for conducting the foul air *from* the tanks.

d, connecting water pipe.

e e, valves for admitting the foul air into the tanks.

f f, valves for allowing the foul air to escape.

The operation of this self-acting ventilator is as follows: Each tank or butt is half filled with water, which flows freely from one to the other through the pipe *d*. The quantity of water running alternately from each depends upon the motion of the ship. When one of the tanks is elevated by the ship's motion, the water will run through the pipe *d* into the depressed tank, and thereby discharge as much foul air through the valve *f* as the additional water displaces. The elevated tank at the same time is receiving the foul air through valve *e*, from the hold of the ship, to supply the vacuum that would otherwise be made by the escape of the water. If the tanks are fixed at right angles with the keel of the ship, the ventilator will operate only with the roll of it; but, if placed diagonally, both the pitch and roll of the vessel will discharge the foul air. It would be most economical to fill the tanks at the beginning of the voyage. The first water for the ship's use should be taken from the ventilating tanks, leaving, however, half of it behind for operation. If the remaining water should ever be wanted for the ship's use, it can be drawn off, and replaced by salt water. It will be seen that, by this mode of ventilating, nothing but the hose and valves are to be added to what must necessarily be on board every ship.

N° XII.

IMPROVED CONSTRUCTION OF THE RIBS OF GROINED ARCHES.

The smaller, or VULCAN GOLD MEDAL *was this Session voted to Mr.* JOSEPH JOPLING, *of Somerset Street, Portman Square, for his* IMPROVED CONSTRUCTION OF THE RIBS OF GROINED ARCHES. *The following communication has been received from him on the subject, and Models of his Invention have been placed in the Society's Repository.*

24, Somerset Street,
Portman Square.

SIR;

I TAKE the liberty of troubling you with the accompanying papers and models illustrating a new method of constructing Ribbed Groins, which you will do me the favour to lay before the Society. When the Committee may be pleased to examine them, it will give me pleasure to attend, and to furnish any explanation that may be required.

I am, Sir,
&c. &c. &c.
JOSEPH JOPLING.

A. Aikin, Esq.
Secretary, &c. &c.

HAVING observed that much difficulty is experienced in executing ribbed groins in plaster, and that the work

is done in a very incorrect manner; and having heard that others have made the same observation, I am induced to offer to the Society of Arts, Manufactures, and Commerce, a few observations, drawings, and models, which, I conceive, may be the means of reducing the expense and improving the appearance of works of this nature.

The desirable object is, to form the surfaces of groins, so that the curvatures of the various ribs may be without cripples, that they may intersect truly, and stand perpendicularly over their respective plans, and that they may be executed by the usual mode of running plaster mouldings.

In the early examples of ribbed groins, few, if any of the ribs, intersect truly at their springing. Whether this occurred through design, or from not knowing the principles of intersection, may be doubtful. If it was intended to imitate the spreading branches of trees, perhaps it was thought more natural for some of the ribs to rise behind others, than that they should intersect truly; yet, as we see other intersections hidden with foliage, it would appear that their not intersecting truly was considered a defect; for instances occur where the intersections being correct, there is no foliage; and in the same groin, where the intersections are not true, foliage is added. Those persons who introduced ribbed groins of the same curvature, it is probable, had discovered that ribs must be of like curvature to intersect truly at their springing; and that ribs of merely like sections would not do so. It is likely that their object, in introducing them, was to have the intersections true. They might also wish to save the trouble of determining the forms of separate ribs, by the slow geometrical process of ordinates. However, the time required to determine the forms of the ribs is not an object, when compared with the time required to execute them.

References to the Figures of Mr. JOPLING'S *method of constructing Groined Arches,* Plates IX and X.

Fig. 1 is the plan of a square groin. At A the corresponding numbers represent the old method of corresponding points of height in the different ribs. At B the corresponding numbers represent the corresponding points of height, by the proposed plan.

Fig. 2, represents the curvatures of the three ribs *a*, *b*, and *c*, according to the old method at A, fig. 1.

Fig. 3, represents the curvatures of the ribs *a*, *b*, and *c*, according to the proposed method at B, fig. 1.

Fig. 4, plan of intersections of ribs, calculated for the old method; this application is shown at C, fig. 1.

Fig. 5, section of *a*, or given rib, fig. 4: the section of rib *e*, fig. 4, is the same.

Fig. 6, section of rib *b*, fig. 4, at the bottom, or springing. This rib must vary from the form of fig. 6 to the form of fig. 5.

The rib *d* will be its reverse. These cannot be executed by a running mould.

Fig. 7, section of rib *c*, fig. 4, at the bottom, or springing. This rib must vary from the form of fig. 7, to the form of fig. 5. This cannot be executed by a running mould.

Fig. 8, plan of intersections of ribs, calculated for the proposed method. Their application is shown at D, fig. 1. By the usual method of running plaster mouldings, the whole of the ribs *a*, *b*, *c*, *d*, and *e*, may be executed.

Fig. 9, plan of intersections meeting in a common point, and showing the two methods, when the ribs are more crowded in one place than another; the application of the old method is shown at A, fig. 15; and the application of the new method at B, fig. 15. The new method may be executed with one mould.

Fig. 10, section of rib *b*, fig. 9, at the bottom, or springing, as required by the old method.

Fig. 11, section of rib *c*, fig. 9, at the bottom, or springing, as required by the old method.

Fig. 12, section of rib *d*, fig. 9, at the bottom, or springing, as required by the old method.

Each of these last ribs must vary from their respective forms to that of the rib *a*, fig. 5, or they will not intersect with the ribs *a* or *e*, or with each other.

None of the ribs *b*, *c*, or *d*, as applied at A, fig. 15, can be executed by the usual mode of running plaster mouldings.

Fig. 13 shows how ribs making the same angles with each other, as in fig. 9, may stand at their springing, so as not to be more crowded in one place than another; their application is shown at C, fig. 15; these may be executed with one mould.

Fig. 14 shows how ribs making the same angles with each other, as in the last, and fig. 9, may stand, so that the height of all the intersections may be alike; these may be executed with one mould; their application is shown at D, fig. 15.

N° XIII.

IMPROVED BLOWING MACHINE.

The large SILVER MEDAL *and* FIFTY GUINEAS *were this Session voted to Messrs.* JEFFRIES *and* HALLEY, *Great Guilford Street, Southwark, for an* IMPROVED BLOWING MACHINE. *The following communications have been received on the subject, and a Working Model of the Machine is placed in the Society's Repository.*

Great Guildford Street, Southwark,
April 28, 1819.

SIR;

HAVING invented a very commodious method of applying large bellows for smiths' and founders' use, which many of our friends flatter us as being likely to be highly beneficial in those and other branches of Mechanics requiring strong blasts, we beg leave to submit the same, with the accompanying certificates, to the consideration of the Society of Arts, &c. &c., being well assured that if the invention possesses any merit, it will meet the Society's liberal patronage.

We are, Sir,
&c. &c. &c.
J. JEFFRIES.
WM. HALLEY.

A. Aikin, Esq.
Secretary, &c. &c.

CERTIFICATES.

Deptford Dock Yard,
December 8, 1819.

SIR;

THESE are to certify whom it may concern that the Honourable Navy Board ordered a Blowing Machine of Messrs. Halley and Jeffries to be made trial of, to see if they would answer the purpose of making large anchors in Deptford Dock Yard. We have made trial, and find them to answer our full expectation.

C. FLEMING, *Master.*

Deptford Yard,
February 4, 1820.

HONOURABLE SIRS;

IN obedience to the directions in your Honourable Board's letter of the the 21st ult., we beg to send you, as follows, answers to the several questions in regard to the Blowing Apparatus invented by Messrs. Halley and Jeffries now under trial at this yard:

1*st*.—The effect produced as compared with the ordinary bellows; and whether it requires more time to prepare a heat with this apparatus than it does with bellows of the ordinary description, supposing the anchors to be of the same weight?

Answer.—The effect is much greater than the ordinary bellows, and, consequently, will prepare the heat in less time, the weight of the anchors being equal.

2*nd*.—The space occupied by it compared with that occupied by the ordinary bellows?

Answer.—The space occupied is not more than one half of that occupied by the ordinary bellows, and might be placed, if necessary, in an elevated situation, entirely out of the footway.

3*rd*.—The cost of the apparatus compared with the cost of the ordinary bellows?

Answer.—The Blowing Machine of Messrs. Halley and Jeffries, as fitted, 52*l.* 10*s.*: walking bellows, of 11 feet (the size superseded by those of Messrs. Halley and Jeffries) being 52*l.* without fitting.

4*th.*—Whether the apparatus, as far as you are enabled to form an opinion is superior or inferior to the blowing apparatus invented by Mr. Street, and in what particulars; and whether in your opinion, this apparatus could be generally or only partially adopted?

Answer.—The master smith is of opinion that the apparatus of Messrs. Halley and Jeffries is superior to that invented by Mr. Street: in the first place, it does not occupy half the space, blows a stronger blast, is not so soon out of order, will last a greater length of time, and requires less labour to work it; and further, that this apparatus appears to be fit for fires where two or more men are employed, but not for single-handed fires.

We remain, &c.

(Signed) Wm. Stone.
Jas. Hillman.
F. J. Hawkes.

(Attested copy) R. Nelson.

Deptford Dock Yard,
March 23, 1820.

GENTLEMEN;

In reply to your application to me for a declaration of my approbation of your invention of the Blowing Machine now in his Majesty's smithery at Deptford, I can have no hesitation to state, that from its performance, before I had inspected its interior, I was impressed with a very favourable opinion of its superiority over all mechanical blasts I had witnessed; and having seen the interior of the model you submitted to my inspection, am of opinion that

its mechanism is simple, likely to be durable, and has confirmed my previous good opinion.

W. STONE, *Master Shipwright.*

Messrs. Jeffries and Halley.

10, Long Acre,
December 9, 1819.

SIR;

IN answer to your request as to my opinion of the bellows you made for Fraser and Chater, I can say that I recommend them with the most perfect confidence; they revolve in little compass, and have a power much beyond their bulk; in fact the invention seems to me of general advantage, as the machines in use at present require much more labour than your's. I have to regret, on your account, that you have no patent, being convinced that the strength, simplicity, and power of your machine must bring it into great request.

I am, Sir,
&c. &c. &c.

Mr. John Jeffries. JAMES FRASER.

Foundry, Upper Ground Street, Christ Church, Surrey,
December 9, 1819.

WE hereby certify, that, having for the last nine months had a pair of Jeffries' and and Halley's Blowing Machines in constant use, we are perfectly satisfied of their superiority over every other description of blast we have hitherto seen used, and the men working them seem perfectly satisfied they save much labour.

WARD & AINGER.

Iron Works, Wandsworth,
March 22, 1820.

Upon a trial this day made of a Blowing Machine by Jeffries and Halley, it was found to have melted a charge of eighteen hundred weight in one hour and ten minutes.

George Day & Son.

Reference to the Figures of Messrs. Jeffries' *and* Halley's *Blowing Machine*, Plates XI and XII.

Fig. 1 is an outline plan of the machine, showing the end opposite to that exhibited fig. 3.

Fig. 2 is an outline plan of the machine in the same position as the section, fig. 4.

Fig. 3 is a view, and fig. 4 a section of the machine, the one at right angles to the other.

The same letters refer to the same parts in all the figures.

a, a cranked handle, worked by two or more men, according to the size of the machine.

b, a fly wheel, fixed on the end of the axis opposite to that where *a* is placed, for the purpose of equalizing the motion.

c, fig. 4, a crank fixed on the middle of the axis, and working in an air-tight semicircular box. By means of this crank the revolving motion impressed at the handle is converted to a reciprocating one, for the purpose of alternately opening and shutting the vertical bellows *d*. These bellows, from their vertical position, require only a small degree of power to keep them in action: they draw in the external air by the valves *k k*, fig. 1, and discharge it through the valve *h*, fig. 4, into the nozzle *e*.

The box, or outer case, in which the vertical bellows are inclosed being air-tight, it necessarily follows, that when, by the action of the crank *c*, the bellows are compressed, a partial vacuum will be formed in the box. In order to restore the equilibrium, a portion of external air will rush in through the valves *i i*, which portion will, by the next succeeding expansion of the bellows, be driven through the valve *g* into the head or regulator *f*, which it inflates and raises, and the top of which may be loaded with weights, in order to give any required degree of compression to the inclosed air. This air is expelled from the regulator through a valve opening downwards into the trunk, of which the nozzle *e* is the exit. The whole of the machine is of iron, except the leathers of the bellows and of the regulator.

N° XIV.

IMPROVED BLOCKS AND SPRINGS FOR WHEEL-CARRIAGES.

The large SILVER MEDAL *was this Session voted to Mr.* FRED. C. CHERRY, *Veterinary Surgeon, Clapham, for his* IMPROVED BLOCKS AND SPRINGS FOR WHEEL-CARRIAGES. *The following communications have been received from the candidate on the subject, and Models of his Inventions have been placed in the Society's Repository.*

Croydon,
May 3rd, 1819.

SIR;

I INCLOSE a paper on the application of Springs to Wheel-Carriages, and request you will do me the favour of laying it before the Society for the Encouragement of Arts, Manufactures and Commerce.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. FRED. C. CHERRY.

Croydon,
April 1819.

HAVING for many years had repeated opportunities of witnessing the imperfections of the various carriages employed for the purposes of military transport, my attention has been directed to the invention of a carriage for general

military purposes, more efficient and more simple than any heretofore in use.

In the course of pursuing this subject, I have employed a simple contrivance, which may be easily applied, at a small expense, to a variety of carriages, employed for a variety of purposes, in civil or domestic life; and it consists of a mode of entirely protecting from injury the ordinary springs of a cart or other carriage, when heavy loads are to be carried; while it admits of their free use when light loads are carried.

Springs to carriages are usually applied of a strength proportioned to the probable average weight of the loads to be carried; so that when the load is much less than the average, the springs will not yield, or at best do so but imperfectly; while on the other hand, a load much heavier than the average overcomes their elasticity and entirely destroys their effect. From excessive pressure springs often get bent, and otherwise permanently injured.

As an attempt at obviating this inconvenience, fixed blocks of wood are very commonly used, so placed as to limit the action of the springs. The evil of this confined action is felt, when light loads are carried, by frequent shocks, by a jolt or thump every time these blocks produce their effect; and when heavy loads are carried, the springs are strained and injured by being kept constantly bent to a degree to overcome the whole of their elastic power that can ever be brought into action.

In searching for information on this subject, I certainly have been told that a block moveable on a centre, has by other persons been employed with the same intention; but still it appears to me, that even this mode, which, however, differs materially from that I am about to describe, cannot have been applied with simplicity and good effect, as in that case we should find moveable blocks in common use.

My contrivance readily admits of full scope for the springs when light loads are upon them; while with equal facility it may be made to remove all strain whatever from the springs, when heavy loads are placed on the carriage.

This change is brought about by the simple action of a horizontal lever pushed from one corner or side of the carriage to the opposite corner or side.

The contrivance to admit of this change consists of two blocks of wood made to slide on the upper surface of the axletree bed; and the means of connecting these sliding blocks with the arm or lever by which they are put in motion.

The sliding blocks are kept on the axletree by thin plates of iron fixed at the side of it; the fulcrum of the lever is a pin fixed in the centre of the axletree; a small iron rod, moveably attached at each end, connects the lever and the blocks respectively; so that pressing the lever in one direction separates the blocks to a greater distance from each other, by which means they are interposed between the axletree and the side pieces of the cart or other carriage, and support it independent of the springs; while, passing the lever in an opposite direction causes the blocks to approximate, withdraws them within the side pieces, and, independent of the resistance opposed by the springs, allows a free descent to the whole body of the carriage, until the side pieces reach the upper surface of the axletree.

When the load is a heavy one, the blocks, by means of the lever, are pushed under the side pieces of the cart or other carriage to bear its entire weight, and are kept in that situation by fixing the end of the lever. When the load is not greater than the springs can properly sustain, the cart or other carriage is allowed to rest on them, by passing the lever to the opposite side, when the blocks are withdrawn from under the side pieces, and are received

into the space produced by the difference in thickness between the boarding of the bottom and the side pieces. By increasing the thickness of the side pieces edgeways, the blocks may also be increased in thickness, and scope for action for the springs obtained to any extent.

It must be obvious that the mode of construction here described will admit of variation, and that there are other ways of bringing about the same end.

The simple contrivance already described, appears to be tolerably perfect as far as it goes, but it leaves the class of heavy loads without the advantages resulting from springs; advantages which it is not necessary for me to make any observations on in this place. I therefore continued my attention to this subject with a view so to apply springs as to adapt them to two averages of loads instead of one; to give the advantages of efficient springs to heavy loads as well as to light loads carried on the same carriage; and this end also appears to be attained to a tolerable degree of perfection.

Now in the course of my inquiries, I have also been since told that springs have been employed by other persons with the same intention; but still, as with regard to the use of blocks, I am induced to believe that the mode of employing them has been imperfect, or from the great benefit to be derived at a small expense, moveable springs would be found in use very generally.

For the purpose already stated, I have employed, instead of the sliding blocks, a stout spring, either straight or curved as may be requisite: this is moveable on a centrical pin similar to the fulcrum of the lever used to give motion to the sliding blocks. To this spring is attached a lever sufficiently oblique to allow its end to rest opposite a convenient place, one hind corner for instance, while the spring lying straight with the axletree has each end respectively under the side pieces of the cart or other

carriage, and contributes to support its weight; which in this case is borne partly by the ordinary longitudinal springs, and partly by the additional transverse one, each being acted on at the same time in a similar degree. The lever being passed to the opposite side or corner, turns or twists the spring in a direction oblique to the axletree, and partly across it; by which means it remains at rest in the hollow space under the boarded part of the bottom of the cart or other carriage, leaving the slighter longitudinal springs full scope for their action. An iron slide fixed to each side piece receives the first pressure from the spring and guides it into its place.

The mode already described applies to the spring being moveable on the centre of the axletree; it may, however, be made moveable on the centre of the bottom of the cart, and the iron slides of direction be placed on the axletree.

Practice will doubtless suggest various other modes of application; but the basis of my ideas on this subject appears to be sufficiently developed in this letter to answer the purpose of bringing the subject into further notice. My own attention will of course be continued, and as soon as some models now in hand are completed, I shall place them at the disposal of the Society.

Rathbone Place,
March 27th, 1820.

SIR;

I HEREWITH send a description to be annexed to the drawings made from the models furnished by me, and tending to elucidate the principle of applying moveable blocks, and an equalizing moveable spring, to carts and other carriages.

Although I have stated in the paper transmitted to the Society in May last, that my attention had been directed

to the invention of a carriage for general military purposes, it was only to show how this subject had first engaged my consideration. The military improvement I have brought under the notice of the proper military authorities, and it is that part alone which appears to me to be equally "applicable to a variety of carriages, employed for a variety of purposes in civil or domestic life," that I have here attempted to explain.

In the paper already mentioned, I describe the moveable spring as attached to the axletree, but state that it may be made moveable on the bottom of the cart: in the model it is so placed, and the drawings also represent it in that situation, which, perhaps, may be considered the best, as not exposing it when inactive to all the concussion the axletree receives. The moveable blocks may also be attached to the bottom of the carriage. The principle of moveable blocks, and equalizing moveable springs, is susceptible of numerous modifications, and either one or the other may be very generally applied to a great variety of carriages, employed to carry at different times loads of very unequal weight, without altering the present mode of construction, and consequently at a small expense.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. FRED. C. CHERRY.

Reference to the Engraving of Mr. CHERRY'S *moveable Blocks and equalizing moveable Spring, for Carts and other Carriages,* Plate XIII.

Fig. 1 represents a plan of the axletree and springs of a cart (the body being removed), and shows the moveable blocks as interposed to prevent the springs being acted on by heavy loads.

a a, the axletree; *b b*, the springs; *c c*, transverse rails uniting the side pieces of the cart; *e*, a lever, jointed at *g*, to give motion to the sliding blocks *q q*, the lever and blocks being connected by the plates *r r*; *l*, a leathern strap for loosely fixing the end of the lever at *m* or *m*.

Fig. 2 represents an elevation of the axletree, springs, and moveable blocks, together with a section of the side pieces and bottom of the cart; the blocks being applied to support the weight of a heavy load.

a a, the axletree; *b b*, the springs; *q q*, the moveable blocks; the lever and connecting plates being removed, *v* indicates its fulcrum; *s s*, plates to retain the sliding blocks on the surface of the axletree: pins fixed in the blocks *q q*, transverse in the plates *s s*, and prevent the blocks rising; *n*, the floor of the cart.

Fig. 3 is similar to fig. 1, but the lever *e* being passed to the opposite side, the blocks *q q* are made to approximate, by which they cease to act, and the springs then sustain the cart in the usual manner.

Fig. 4 is similar to fig. 2, but the blocks having been made to approximate, the cart is allowed to rest on the springs, and by their yielding to descend through the space *u u*.

Fig. 5 is a side view of the lever, and shows the moveable joint *g*.

Fig. 6 shows more clearly the use of the joint *g*, in the lever *e*; when the springs *b b* are acted on, the cart *n* descends, and with it the oblique part of the lever *e*, but the joint allows the horizontal part *f*, to retain that situation. As the oblique part of the lever *e*, approaches to the situation of a right line with the horizontal part *f*, it elongates backwards, and occasions a necessity of employing some kind of attachment for the end of the lever that will admit of this motion: a strap and buckle answers

the purpose very well: *a*, the axletree; *o*, the shaft; *q*, the moveable block.

These six figures are intended to explain the mode of applying and using the moveable blocks: it must be obvious that when the lever is passed to the right, the blocks will be separated to a distance from each other and interposed between the springs and the side pieces of the cart, so as to support it, and completely prevent any descent. It must be equally obvious, that when the lever is passed to the left, the blocks will be made to approximate; that they will be withdrawn from under the side pieces of the cart; that the cart may then descend as the springs yield, since the difference between the thickness of the side piece and the thin-boarded bottom, gives space for this action to take place, as particularly shown in fig. 4.

Of course but one mode is here described of applying this invention; but by employing a little ingenuity, it will be found that the principle may be applied to almost every cart in common use.

Fig. 7 represents an axletree *a a*, with the ordinary side springs *b b*, and an additional moveable spring *d*, which may have any convenient degree of curvature, resting by its extremities on the axletree; it is attached to the bottom of the cart by a bolt at *v*, acting as a fulcrum; *e* is a lever fixed by a strap *l*, or otherways to the hind part of the cart at *m*, to keep it in that situation; *i i* are iron slides of direction to receive the first pressure from the ends of the spring, and guide it to the situation here represented. The cart being loaded, this spring acts in conjunction with the other two, and the whole yield in an equal degree; *c c*, transverse rails uniting the side pieces of the cart.

Fig. 8 is similar to fig 7; but the lever *e* being passed to the opposite side of the cart, and fixed at *m*, the moveable spring *d* is placed obliquely across the axletree *a a*, and

remains at rest, the cart being in this case entirely supported by the side springs *b b*.

Fig. 9 represents an elevation of fig. 7; *a a*, the axletree; *b b*, the side springs; *d*, the moveable spring; *e*, the lever acting on the moveable spring; *h** a transverse bar of wood or iron fixed at the bottom of the cart, and to which is attached the moveable spring; *n*, the bottom of the cart; *k k*, leather straps to restrain either side of the cart from rising when the other is depressed.

The lever *e* being passed to the opposite side, places the moveable spring *d* obliquely across the axletree, as shown in fig. 8, by which it remains inactive, while the body of the cart resting on the side spring, descends through a space given by the curvature of the spring *d*, equal to *f*, which space may be increased in various ways.

The principle of a moveable spring is susceptible of a very great variety of modifications.

Fig. 10 is a side view of fig. 8, and shows the slope of the iron slides of direction *i i*, and the position of the moveable spring *d*, when at rest.

Clapham,
October 30th, 1820.

SIR;

SINCE my last communication on the subject of moveable blocks, and equalizing moveable springs for carts and other carriages, I have applied moveable springs to two carriages belonging to the private establishment of his Majesty: in the first instance to a luggage cart, employed to carry at different times loads of very unequal weight, and perhaps the best certificate of its utility is the fact of my being afterwards directed to apply additional springs on my principle, also, to a four-wheel carriage, the effect in both cases obtaining full and complete approbation.

* In the engraving, *b* has, by mistake, been substituted for *h*.

The weight of every article used in applying the spring to the cart being 12 lbs., and the two springs to the four-wheel carriage 18 lbs., exclusive of the weight of the springs themselves, which are of an ordinary make.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. FRED. C. CHERRY.

P. S. I shall be happy to remove any difficulties that may occur in the practical application of the invention here described, on application being made to me at my house at Clapham.

N° XV.

HOSE FOR FIRE ENGINES.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* JACOB PERKINS, *of London, for his* METHOD OF FASTENING THE SEAMS OF HOSE FOR FIRE ENGINES, AND OF CONNECTING TWO OR MORE LENGTHS OF HOSE TOGETHER. *The following communication has been received from the candidate on the subject, and a specimen of the Hose has been placed in the Repository of the Society.*

No. 29, Austin Friars,
Dec. 22nd, 1819.

SIR;

HAVING made some improvements in the Leather Hose for Fire Engines, which I have found to answer well in America, I am desirous of submitting them to the notice of the Society for the Encouragement of Arts, Manufactures, and Commerce; and will attend to explain

them before the Committee to whom the Society may refer them, upon being informed when they will be taken into consideration.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. JACOB PERKINS.

Reference to the Engraving of Mr. PERKINS' *Improved Hose for Fire Engines,* Plate XVI.

Fig. 1, a view of two pieces of double-rivetted hose, united by swivel joints.

Fig. 2, section of the above, showing that at the swivel joints, the water way is not contracted.

A, B, the swivel joint and female connecting screw.

C, male connecting screw.

a a, swivel joint ring.

b b, groove for swivel joint ring.

Fig. 3, section of parts of the connecting screws, on an enlarged scale.

Fig. 4, end view of the rivetted hose.

Figs. 5 and 6, end and side sections of the hose, as fastened to the connecting screws.

Fig. 7, view of the method of joining the hose.

Fig. 8, end section of the hose.

Fig. 9, side section of it.

The improvement in this hose is in rivetting, instead of sewing it; and in connecting the hose with a new modification of the swivel joints, in such a manner as not to contract the water way at the joints. The first idea of rivetting hose, belongs to Messrs. Pinnock and Sellers, of Philadelphia, and has been in successful practice 12 or 13 years, but without the leathers being overlapped sufficiently. The method of connecting the hose belongs to

Mr. Perkins. The advantage of rivetting over sewing, is, that the seam lasts much longer, and is much tighter. The rivets, which should be made of copper, will last 4 or 5 times longer than the best thread. If care is taken to have sufficient overlap (see fig. 8), the pressure of water against the overlap, acts as a valve to tighten the seam. It has been found by experience, that the portion of hose next the engine, is much the most likely to burst, especially when the water is carried perpendicularly; to obviate this difficulty, the 1st, 3rd, or 4th portions (see fig. 1) are double-rivetted.

The method of connecting the different portions of hose is as follows: figs. 2 and 3 show sections of the male and female connecting screw and swivel joint; A forms the female part of the swivel joint, which is attached to the hose, by being screwed within the female screw *c c*; it is prevented from collapsing, by the brass ring *d* within it. On the outer side of this female screw is a groove *b b*, in which revolves the swivel ring *a a*; this swivel ring is fixed to the female connecting screw B, by means of rivetting over the end of it at *f*. The male screw C, is attached to another portion of hose, in the manner before described.

Fig. 4, end view of the hose as rivetted, showing also the overlap.

Fig. 5, section of that part where the hose is fixed to the connecting screws. The brass ring *d*, expands the hose, *g*, sufficiently to allow a screw to be cut on the leather embracing the ring *d*, by the female screw B.

Fig. 6 shows the manner of holding the hose while in the act of screwing it into the connecting screw (see A and C, in fig. 2). D, a block or cylinder of wood just large enough to pass through the ring *d*; this block prevents the hose from collapsing while it is held (in a vice,

or otherwise), for the purpose of resisting the action of forcing on the screw *c c*.

Fig. 7 shows the means of connecting the different pieces of leather that compose the hose, which is effected by a spiral joining of double rivets.

Fig. 8, end section (full size) of the hose, showing the overlap or valve.

Fig. 9, side section (full size) of the rivet seam.

When a rivet breaks, it is replaced by making an opening in the seam, of sufficient size to allow the hand to replace not only the broken rivet, but the rivets taken out to enlarge the opening. After the rivets are fixed in the holes, they are rivetted by placing them on a flat bar of iron, introduced in the entrance of the hose, and capable of being removed at pleasure. Copper has been found to answer best. It is of such importance that the rivet and burr should be of the same material, that it would not answer well to have the rivets of *cast* copper (they being an alloy of tin and copper), and the burr of *wrought* copper. Tin rivets, with copper burrs, will completely destroy the leather in a few months, occasioned undoubtedly by the operation of galvanism.

N° XVI.

IMPROVED SHIPS' PUMP.

The large Gold Medal *of the Society was this Session presented to Mr.* Jacob Perkins, *of London, for his* Improved Ships' Pump. *The following communication has been received from the candidate on the subject, and a Model of the Pump has been placed in the Repository of the Society.*

29, Austin Friars,
January 10, 1820.

SIR;

I beg to submit, for the approbation of the Society for the Encouragement of Arts, Manufactures, and Commerce (of which I have the honour to be a member), a model of a Ship's Pump, which has the advantage of being capable of being constructed of materials always to be found on board, and by any ship's carpenter, without the necessity of boring the barrel, as in the usual pumps; the construction of the valves in the piston and foot valve will also be found exceedingly easy, and to afford a large water-way; and, although the principles on which they are constructed is a modification of one of the objects of a patent granted to me; yet, should the Society approve of it, I am willing to wave any advantage from it, in favour of the British public.

The construction of this pump is so simple and obvious, that it scarcely requires any explanation; but, should the

Society require it, I shall be happy to attend the Committee appointed for its examination.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JACOB PERKINS.

The object of the peculiar modification of this pump is that of enabling sea-faring people to construct a pump while at sea from materials always to be found on board; viz. deal boards or planks, leather, nails, canvas, and tar.

This pump is constructed as follows: take four strips of deal boards of suitable width and length, nail them firmly together, so as to form a square trunk: this trunk is next covered entirely with tarpaulin; then another layer of boards is nailed over the trunk, observing to break the joints (see figs. 4 and 5, pl. XVII.) A third layer of boards nailed firmly to the first and second layer will complete the body of the pump, if of a common size (say 5 inches); but if the pump is larger, it may be strengthened by adding more layers of boards. For the form of the valves, see fig. 3. The substitute for the upper box of the common pump consists of two isosceles triangular valves the sides of which are double the length of the base, jointed with leather to two square pieces of boards (hard wood, if convenient). These two pieces of board, to which the valves are jointed, play diagonally in the pump (see figs. 1 and 2). Between these two pieces of board, is fastened with nails, the pump rod, which is also made of deal board: the leather which forms the joint should be extended over the sides of the valves, so as to form the stuffing as the valves lie obliquely in the angles of the pump. The inside of the valves may be loaded with sheet lead, if convenient; at any rate, they should be filled with as many nails as the valves will hold without weakening them. The upper

valves are furnished with a check string (see fig. 3, valve B), to prevent the friction of the valves on the sides of the pump; this check, which may be made of small line, is very important to the ease of working the pump. It should be so adjusted as to prevent the valves from resting on the sides of the pump, the leather only should touch the pump. The lower valves, which are fixed to the bottom of the pump, are made similar to the upper valves, with the exception of the rod and check. Between the lower valves a piece of hard wood, for hooking up the valves, if no sheet iron or copper is at hand, should be fastened (see fig. 3, valve F).

This pump works very easily, owing to the water way by the valves being much greater than the water way through common boxes. It is not liable to choke, in consequence of the water not being *wire-drawn* below the boxes or valves; for the water way below the valves may be so contracted as to draw up even iron; but, by enlarging the bottom of the pump, this will be remedied.

References to the Engraving of Mr. PERKINS' *Ships' Pump,* Plate XVII.

Fig. 1, a side section of the pump.

Fig. 2, a diagonal section of ditto.

A A, body of the pump, figs. 1 and 2.

C C, pump rods.

D D, upper valves.

E E, lower valves.

Fig. 3, upper and lower valves; B the upper, F the lower valve.

Fig. 4, upper end of trunk.

Fig. 5, lower end of ditto.

The dotted lines mark the places in which the sections figs. 1 and 2 are taken.

N° XVII.

DRAWING OFF THE BACK WATER FROM WATER WHEELS.

The smaller, or VULCAN GOLD MEDAL *was this Session presented to Mr.* JACOB PERKINS, *of Austin Friars, London, for a* METHOD OF DRAWING OFF BACK WATER FROM WATER WHEELS. *The following communication has been received from the candidate on the subject.*

Austin Friars,
March 8, 1820.

SIR;

I REQUEST that you will have the goodness to lay before the Society of Arts, &c., the inclosed communication relative to a method invented by me of drawing off the back water from water wheels.

This improvement in mills is that of using part of the superabundant water in times of floods, or freshets, to free the water-wheels from the back-water occasioned by such freshets. To effect this purpose, the following plans have been successfully adopted: Plate XIX is a view of a section of a water-wheel, and the system of forcing off the back-water, which accumulates in time of floods. A represents a water-tight tube, or trunk, being the breadth of the wheel, and the depth of the buckets, running from the bottom of the penstock, to or past the center of the bottom of the wheel. B is a receiving tube, or trunk, being one third larger than the small end of the

tube A, and is also in a direct line with it. E is an opening between the tubes A and B; at this opening the back-water (which had accumulated under the wheel, while the current was cut off by the gate *a*), is carried off by the lateral velocity of the current, which rushes from the tubes A and B. C represents the back-water; D the bulk head. It will be readily seen, that, by opening the gate *a*, the water will rush down the tube A, and join the back-water at E, and with it, pass off through the tube B, under the bulk head D. The water expended in turning the water-wheel will also be carried off by the same current through the tube B. Plate XX, fig. 1, is a back view of a water-wheel, with the tube A running at right angles to it; but this modification is only used when the wheels are already built. Fig. 2 is a plan of the same. In this case the water is brought from the dam, or reservoir, by a curved channel, or otherwise, as may suit the situation of the wheels. The same letters of reference apply to the same parts in both plates.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c JACOB PERKINS.

N° XVIII.

SPRING LATCH.

The smaller, or VULCAN SILVER MEDAL *was this Session voted to Mr.* ALFRED AINGER, *of Everett Street, London, for a* SPRING LATCH. *The following communication has been received from the Candidate on the subject, and a Model of the Invention is placed in the Society's Repository.*

Everett Street,
March 16, 1820.

SIR;

I INCLOSE for the inspection and judgment of the Society of Arts, &c. an improved draw-back Spring Latch, the peculiar construction and advantages of which I shall be happy to explain to the Committee, on being duly apprized of the time appointed for its consideration.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.
Secretary, &c. &c. ALFRED AINGER.

In the construction of the lock described in the annexed engraving (plate XIV), the two following objects were proposed. In the first place, to render it more difficult of violation by a pick than those in general use; and in the second, to apply a key to it, of which no ordinary person could take an impress, and which, even in a workman's hands would be very difficult of imitation. Figs. 1

and 2 represent a plan and section of the lock divested of the key, and of the springs which press the tumblers towards each other: *a a* is the plate or case of the lock; *b b*, the bolt which is moved by a pinion *c*, acting in a rack *d*; *e f* are the tumblers (of which four or more might be used, though two are sufficient to exhibit what are deemed the improvements). These tumblers have projections at their ends which dip into the grooves *g h* cut in the bolt. The projection of *e* (see fig. 2) is equal to twice the thickness of that part of the bolt in which the grooves are formed, but the projection from *f* is only half that quantity, in order to avoid in its passage the spring *i*, which is seen across the groove *h*, and whose situation under the bolt is described by a dotted line. The shape of the projection is shown at *k*, fig. 3: they are guided by the key through the grooves, as will be described; it is first, however, requisite to explain the nature and effect of the spring *i*. Fig. 4 shows the under side of the bolt with the grooves and the notches on a larger scale; it also exhibits the partial reduction of half its thickness, in order to contain the spring. The notches 1, 2, 3, 4, 5, 7, and 8, are similar in their nature and mode of action to the securities already applied to locks of various descriptions: it will be seen that the notches 2, 3, 4, 7, and 8, have a hook or beak not attached to Nos. 1 and 5. In the notch 8 this hook or beak is formed by a catch at the end of the spring *i*, so that it will recede towards 7 by a slight pressure on its beviled edge; its capability of doing this totally prevents the possibility of disengaging one tumbler from the notches at a time, which is the practice pursued in attempting to pick locks, and by which means the tumblers are removed from the situations in which the pressure of the springs places them, as is shown by the dotted lines in 3 and 7, and they are placed one after the other, as described in 4 and 8, in which position they offer

no impediment to the motion of the bolt; but this effect cannot be accomplished in the notches 2 and 6, care being taken that the projection made by the spring be somewhat greater than that in the opposite notch. When this is the case, if, for instance, it was attempted to relieve the tumbler out of No. 2 first, it is evident it would fall in again before No. 6 could be disengaged, and the contrary mode is impossible, because, as soon as the pick ceases to act on the tumbler, its pressure would repel the spring, and it would again take its old situation.

The form of the key is described in figs. 5 and 6; the lower part of fig. 6, supposed to be a section showing the internal chamber, or pipe, in three divisions, the upper and lower being circular, and the middle one triangular: the use of these three parts may be better understood by referring to fig. 7, which is the pinion *c*, drawn on a larger scale: *a a* is part of the lock plate in which an iron pin is fixed; round this pin the cannon pinion *c* turns, having the lower part of its barrel circular, and the upper part formed of as large a triangle as can be inscribed in the circle, and having one side circular, as seen in fig. 1; immediately above, on the extremity of the iron pin, is fixed a similarly shaped piece of metal *m*, secured from revolving by a pin passing through it; when, therefore, the key is introduced, this part not turning with the rest, it requires that a second portion of the chamber should be cylindrical, to permit its remaining stationary during the motion of the key. To the lower extremity of the key are attached two irregularly curved collars *n* and *o*, fig. 5, each of which acts on one tumbler, and causes them, during the motion of the bolt, to describe curves similar to the grooves *g* and *h*. To prevent either collar from touching the tumbler for which it is not intended, a portion of each of the latter (being the upper part of one and the lower part of the other) is removed (See figs. 2 and 3).

Fig. 8 describes the means of making a secret or master key on this principle: the lower part of the pipe (which is supposed to be manufactured in two lengths, and afterwards brazed together), is formed into an octagon and surmounted by a screw; the pieces *x* and *y*, similar in their nature to the collars before described, and having octagonal perforations, are to be slipped on to the pipe of the key, and followed by the screw nut *z*. The two lengths of the key, being then soldered or brazed together, the three pieces *x y* and *z* can never be lost, being secured from coming off by a small fillet *p*, which buries itself in a recess formed in the piece *x* for that purpose. The appearance of the key when the collars are on the octagon, and the nut screwed down, is described in fig. 9. Though the collars cannot be wholly removed, it is evident that by withdrawing them from the octangular to the cylindrical portion of the key, they may be turned round, and made to take any required position on the octagon; and if letters or figures were engraven on each of its sides, the collars might be withdrawn and returned to their places by the person acquainted with the secret, while to others there would be 512 chances to one against their being able to make use of it.

Figs. 10 and 11 exhibit the means of rendering a draw-back lock as difficult to pick when on the first shoot as when double locked: *q q* is the bolt acted on by the spring *t*, and having the piece *s* attached to it; *r* is an inner, or secondary bolt, to which may be applied any species of security now in use for locks. It requires only to be made long enough to receive the apparatus for giving it such security, and therefore its length is not defined. It is connected with the bolt *q* by a stud holding in the piece *s*, thus permitting the latter to recede by striking against the staple, while the key-hole having

communication only with the inner or secured bolt *r* there will be as much difficulty in picking it while on the latch or first shoot, as in other cases when double locked.

N° XIX.

MERCURIAL LOG-GLASS.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* C. H. JENNINGS, *of Carburton Street, Fitzroy Square, for a* MERCURIAL LOG-GLASS. *The following communication has been received from the candidate on the subject, and one of the Glasses is placed in the Society's Repository.*

25, Carburton Street, Fitzroy Square,
April 4, 1820.

SIR;

I HAVE the honour to send for the inspection and approbation of the Society, a Log-glass invented by me: it is intended to correct the errors constantly attending those at present used; the particles of sand with which they are generally filled being liable to cohere, particularly in damp weather, and thus to impede and even stop the performance of the instrument.

The present log-glass runs so as to answer for both the long and short glass; the former is used when the ship's rate of going is slow, the latter when she has great velocity. It is intended to be exhausted of air, so that no oxidation of the mercury can take place, nor will it be influenced by the expansion, &c. of the air, which is the case with the sand glasses. The fluid mercury runs

equally and more correct than sand, which always forms a hollow cone as it is running.

Those glasses have been much approved by nautical men; they are manufactured by Messrs. W. and T. Gilbert, mathematical instrument makers to the Honourable East India Company, Leadenhall-street.

Should this instrument deserve attention, I beg it may be placed among those valuable instruments and machines in your repository, which are so honourable to this country and to the Society.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. H. C. Jennings.

Reference to the Engraving of Mr. H. C. Jennings's *Log-Glass,* Plate XV.

Fig. 1, a section, *a a* the iron collar into which the two glasses *b b* are cemented; *c d*, two steel pipes fitted in the iron collar, so long as always to be above the surface of the mercury, and the glasses *b b* are so wide as to hold the mercury clear of the pipes in all positions: *e* the mercury, which is now running through the smallest aperture *c*, in 28 seconds (as marked on the glass, fig. 2); when inverted, the aperture *d* allows it to run in 14 seconds: *f*, a steel screwed mouth-piece to introduce the mercury, which may then be cemented up, or a valve may be applied and the glasses exhausted of air: *g* a steel cap to screw on to keep all safe. The glaases are secured by a horizontal circular piece of wood at top and at bottom, which are kept in their places by three screws *i i* which pass through the tubes or hollow pillars *k k*, one of which is shown in section: *l l* the screw nuts.

Fig. 2 shows the whole together, 14 and 28 being marked on the glasses: they are represented of one-third the real size.

N° XX.

IMPROVED MUD-BOAT.

The large SILVER MEDAL *was this Session presented to Mr.* RICHARD PERING, *of his Majesty's Dock-yard, Plymouth, for his* IMPROVED MUD-BOAT. *The following communications have been received from the Candidate on the subject, and a Model of his Invention is placed in the Society's Repository.*

Plymouth Dock-Yard,
May 8, 1819.

SIR;

I HAVE to request you will do me the honour to lay before the Society of Arts, &c. a model of a boat fitted with apparatus, showing how an easy and quick discharge of mud, &c. may be effected, without the usual practice of the men being under the necessity of standing in the midst thereof, to discharge it by scoops or shovels.

On the 30th July, 1817, I proposed to the Honourable Navy Board to fit a boat for this purpose, which was ordered; it was tried on a vessel of twelve tons, and being found to answer, one of twenty-four tons was also fitted with lifting buckets, both of which are in daily use—another of fifty tons is now nearly finished.

The discharge of the cargo is so quick, that although the boat may be aground, she will lighten much faster than the fall of tide, consequently may always be hauled off. In close harbours, where great deposits take place, and it is necessary that they should be cleared, boats so fitted may be useful. The uprights and boom by which the buckets are lifted may be lowered at pleasure; the boat may be rowed, towed, or sailed.

Herewith you will be pleased to receive certificates of its being effectually employed.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. R. PERING, *Clerk of the Checque of his Majesty's Dock Yard, Plymouth.*

CERTIFICATES.

Plymouth Yard,
August 24, 1819.

SIR;

THE model of the Mud Boat constructed according to your invention, and in use upon a small scale at this yard, having been examined by us, we think it right to express our satisfaction and approbation of the plan, conformably to which we shall direct the officers to build a boat of proper dimensions for the use of this port, and to send a model of the same to the Navy Office, to submit to the inspection of the Board.

We are,

&c. &c. &c.

(Signed) T. B. MARTIN.
R. SEPPINGS.
P. FRASER.

(A Copy) W. GADWELL.

Plymouth Yard,
May 7th, 1819.

SIR;

I BEG leave to inform you with respect to the new planned Mud Boats, that in my opinion they are very beneficial to his Majesty's service, being unloaded in half the time with the same number of men that a boat takes of the same tonnage on the old plan; they are also of

great benefit to the men employed on that service, as the unloading is now performed with much greater ease and cleanliness. The discharging of the old mud boats would often envelope the men completely in mud, whereas the new planned boats with tubs, are unloaded without the least filth whatever.

N. DUNFORD, *Foreman of Scavelmen.*
Rich. Pering, Esq. Clerk of Checque.

References to the Engraving of Mr. RICHARD PERING'S *Mud Vessel,* Plate XVIII.

Fig. 1 is a side view of the vessel, having the two middle buckets elevated to a position proper for delivering the mud.

Fig. 2 is a cross section, and fig. 3 is a plan or view on the upper side of the vessel with the two middle buckets in the same position as in fig. 1.

Fig. 4 is a side view of the wheels or crane for elevating the buckets.

Fig. 5 is a side view of the catch wheel, roller, &c., for retaining the block and pulley perpendicular between the two buckets which are to be elevated.

Figs. 4 and 5 are shown in the same situation as in fig. 1, but on an enlarged scale.

The same letters of reference refer to the same parts in each figure.

A A, a boat or vessel something similar to those formerly used for removing mud, &c. But in place of filling the middle part of the vessel with mud, I have fitted it up with six buckets B B B, &c., (to retain the mud), which turn on hinges or joints *a a*, &c. fixed on the upper edge of the boat; C C, two uprights or posts,

having a pulley *b b* fixed in the upper end of each, over which the ropes pass to elevate the boom, or beam D, which is supported by brackets fixed to the uprights C C. The uprights and boom can be erected and lowered at pleasure; on the boom D is suspended a block *c*, which may be slidden from one end to the other, and retained in any required position by the chain *d*, one end of which is fixed to the block *c* and the other to the roller *e*; at one end of the roller *e* is fixed a catch wheel, having a catch *g* acting in it to retain the block *c* perpendicular between the two buckets which are intended to be emptied. A winch also is fixed on each end of the axis of the roller *e*. To the under part of the two buckets opposite each other is fixed a chain *h h*, having a loop or link *i* sufficiently large to prevent the chain dropping between the two buckets when lowered to their situations for loading.

When the buckets are to be emptied, one end of the chain *j*, which passes over the pulley in the block *c*, must be hooked into the loop *i*, the other end of the chain *j* being previously fixed to the roller *k*; then, if the winches or handles *l l* be turned, motion will be given to the pinion *m*, which is fixed on the same axis; the pinion *m* gives motion to the wheel *n*, which is fixed on the same axis as the pinion *o*; the pinion *o* works in or gives motion to the wheel *p*, which is fixed on the end of the axis of the roller *k*, to which the chain *j* is fixed; when the buckets are to be lowered, the brake *q* (which acts against the periphery of the wheel *p*) must be pressed against the wheel *p* by the lever *r*; the pole *s* must be lifted up, and the axis on which the pinion *m* is fixed, must be drawn longitudinally, till the pinion *m* is out of gear with the wheel *n*; then the velocity of the buckets going down may be easily regulated by the lever *r*; a chain *t t* is likewise fixed to the two buckets to prevent them from being overturned.

N° XXI.

APPARATUS FOR THOSE WHO HAVE LOST AN ARM.

The smaller, or VULCAN GOLD MEDAL *was this Session voted to* CAPTAIN GEORGE FITZGERALD STACK, *54th Regt., Thayer Street, Manchester Square, for his* APPARATUS FOR THE USE OF THOSE WHO HAVE LOST AN ARM. *The following communication on the subject has been received from the candidate, and the Apparatus is placed in the Repository of the Society.*

8, Thayer Street, Manchester Square,
January 17th, 1820.

SIR,

HAVING lost my arm in the Peninsula, I have since experienced the greatest difficulty in keeping writing or drawing paper sufficiently steady either to cut, rule, rub with india rubber, fold or seal letters, &c. &c. The duty of an officer requires that he should write in the soldiers small account books to the number of near a hundred every month, which duty I found it impossible to perform without the assistance of a second person to keep the books open. The small weights commonly in use for the above purposes, only press on the center of the paper, by which the sides are lifted up, throwing a shade on it very troublesome, and also causing a great delay, as the pen must be laid down every time the weight requires to be changed. There is not any instrument in use that can

take *instantaneous* hold of a pen, pencil, or other article, when let go by a person who has lost the arm *above* the elbow joint, the common vice requiring a second hand to turn the nut. I have, in order to obviate as much as possible the before-mentioned difficulties, invented an apparatus, on which I improved, and now find that it answers all the purposes required at a writing-table.

The pincers (which act as a pen-holder, &c.) are also of great use to me in various other ways, and particularly so at a dressing-table. I now take the liberty of laying the said apparatus, with drawings of it (which I have been enabled to execute), before the Society for the Encouragement of Arts, &c., and shall feel highly gratified if it meets with their approbation. I beg also to say, I shall be most happy to attend in person to give any explanation that may be necessary.

The invention of Mr. T. Lane,* although certainly very ingenious, and highly useful to any body who has lost only a *hand*, is not of the least use to me; neither can the pen-holder increase or decrease the pressure instantaneously.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. GEO. FITZGERALD STACK,

Capt. Half-pay, 54th Regt.

Reference to the Engraving of Captain STACK'S *Apparatus,* Plate XXI.

Fig. 1 represents the entire apparatus, attached to a table, and ready for use.

Fig. 2 is a bird's eye view, and fig. 3 a horizontal view of the ruler, the vice, and parts attached to them; the

* See Vol. 36, p. 74.

same letters of reference indicate the same parts in all the figures.

a, the ruler, formed of a steel plate, from nine inches to a foot long, one inch and a quarter wide, and one-eighth of an inch thick. It is pierced by five holes on each side; *b b*, &c. inserted near the edges for the purpose of fastening a piece of glove leather to the under surface, in order to prevent the paper, &c. from slipping. A scale of parts is to be engraved on the ruler. One end of the ruler is cut off at right angles to the sides, the other terminates in a joint *c*, by which it is attached to the vice.

e, the vice, secured to the table by means of the screw *f*, and united with the ruler by the joint *g*, which is secured by the screw *h*.

i, a strong spring inserted into the ruler by a rivet passing into the hole *k* and capable of being tightened or relaxed by the screw *l*, which works in the hole *m*; the use of the spring is to cause the ruler to press firmly on the paper or book which is beneath it.

n, a lever, hooked at one end, and fastened at the other end by means of a small screw into the hole *o* of the ruler: near the middle of the lever is a transverse hole *p*, through which the screw *q* passes, and thus serves as a fulcrum to the lever, at the same time securing it in its position by passing into the hole *r* of the vice.

s, a square socket in the vice *e*, which receives the short leg of the pen-holder, fig. 7, and is commanded by the attached screw.

Figs. 6 and 7, a spring pincers called the pen-holder: the jaws are formed so as to receive pens and pencils without crushing them. The jaws naturally stand open in consequence of the action of the spring, and the width of their gape is limited by the screw and nut *t*, which also serves to keep them permanently closed when required.

Fig. 8 is a pointed cylindrical piece of wood to be inserted into the barrel of the pen previously to its being nibbed, as shown fig. 1.

v, fig. 1, is a walking stick, to the thicker end of which is fastened a cord having two rings, one *w*, at one end of the cord, the other *x*, a few inches from the same end; the ring *x* receives a hook fixed to one end of a piece of strong catgut *y*, which at the other end is furnished with a loop that goes on the hook of the lever *n*, and thus enables a person, by pressing on the walking stick with his foot, to raise the ruler *a*, and disengage the book or paper beneath.

The terminal ring *w* is secured in a swivel, shown at large, fig. 5, to the other end of which is also fastened a piece of catgut, which passing over the little pulley *z*, is fastened by means of the knot which terminates it, in the notch *z*, of the longer leg of the pen-holder, the jaws of which are closed by pressing with the foot on the stick *v*.

Fig. 9, a walking stick, pointed at one end, to fix in the ground, and furnished at the other with a square socket to admit the short leg of the pen-holder when the apparatus is used in camp or in the field. When the use of a table can be obtained, the stick then acts the part of a treadle, as *v*, fig. 1.

Nos XXII, XXIII, XXIV, AND XXV.

NAVAL IMPROVEMENTS.

The GOLD MEDAL *of the Society was this Session presented to Mr.* W. HOOKEY, *Master Shipwright's Assistant, Woolwich Royal Dock Yard, for the several* NAVAL IMPROVEMENTS *which form the subject of the four following communications. Models of the improvements are placed in the Society's Repository.*

Woolwich Yard,
Jan. 27th 1820.

SIR;

I HAD the honour of addressing a letter to you some time since, in order to claim as my own invention, a plan laid before the Society by another person, relative to the construction of ships' and boats' rudders; I now beg to present to the Society models of my rudders, which I have adapted ever since the year 1813.

Before I employed this plan, I had convinced myself that generally the rudders of all vessels are much too heavy, so that in fact the rudders incur weakness by that which was intended to give them strength, as their great weight destroys, or has a tendency to destroy, the pintles and braces which are their only security. I therefore reduced the weight of the rudder very considerably, and by attaching it in the manner shown in the models, I increased its power, the effect being thus rendered sensible the moment the tiller is moved from the middle line.

According to the former plan, large scores were cut in the rudder below the surface of the water, and a great vacancy was left between the rudder and vessel, whereby much water escaped, and the tiller was in consequence obliged to be put over considerably before the effect was felt, and by this means a great body of water was carried along, which must necessarily retard the rate of sailing. That much power must necessarily be lost in the way I have described, will be obvious, if we consider what would be the effect of boring great holes in the rudder; in this case it is evident much fluid would escape without producing any effect; and just in the same way does the water, as I have described above, escape between the vessel and rudder. My object has been to follow nature as nearly as possible; and looking to the tail of a fish for my example, I have endeavoured to construct my rudder to operate in the same manner. How far I have succeeded is not for me to determine; but on this head I cheerfully leave my claims in the hands of gentlemen in every way competent to judge of the merits of my construction, and shall only add that I have the honour to remain,

Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. Wm. Hookey,

Master Shipwright's Assistant.

Reference to the Engravings of Mr. Hookey's *Improved Rudders,* Plates XXII, XXIII, and XXIV.

Plate XXII represents Mr. Hookey's method of constructing the rudder and stern post of a boat.

Fig. 1 is a side view of the stern-post and ruder, as formerly constructed.

Fig. 2 is a horizontal section of the above.

Fig. 3 is a side view of the stern-post and rudder on Mr. Hookey's improved principle.

Fig. 4 is a horizontal section of the above.

Fig. 5 is an end view of the stern and stern-post, without the rudder.

Fig. 6 is an edge view of the fore part of the rudder.

a a is the false stern-post, having a circular groove in the after part, to receive the rudder, the fore part of which is cylindrical; by which means the water is prevented from entering between the stern-post and rudder, which adds power to the rudder, and does not retard the boat, as will be seen by comparing it with figs. 1 and 2; if the rudder is separated from the stern post, the way of the boat will be retarded in proportion as the area of the rudder is to that of the boat.

b is a chuck to prevent ropes from getting between the stern-post and rudder; the groove in the stern-post is a guide for directing the pintles into the braces, when shipping the rudder.

c is an eye-bolt for a man to take hold of, in case of his being near the rudder when fallen overboard by any accident.

Plate XXIII represents the stern and rudder of a merchant ship.

Fig. 1 is a side view of part of the stern of the vessel and the rudder.

Fig. 2 is an end view of the stern and stern-post, without the rudder.

Fig. 3 is a side view of the rudder.

Fig. 4 is an edge view of the same.

a is a circular piece of oak, secured by screw bolts, by which means the rudder is very easily hung or unhung, when the ship is in dock, or afloat.

b b are two chucks with a brass collar, which acts as a pintle, and also prevents the rudder from being unshipped.

c is an iron tiller, at the after part, if there is room to use it; if not, of course at the fore part.

Plate XXIV represents the stern and rudder of a 1,600 tons ship.

Fig. 1 is a side view of part of the stern of the vessel and the rudder.

Fig. 2 is a plan of the above.

Fig. 3 is an end view of the stern and stern-post, without the rudder.

Fig. 4 is a horizontal section, at the level of the dotted line *z z*, of the deadwood and rudder.

Fig. 5 is a side view of the rudder.

Fig. 6 is an edge view of the same.

Fig. 7 is a plan, and

Fig. 8 a section of the lower braces which receive the pintle of the rudder; the lower pintle to be five inches in diameter, and made of gun metal.

In figs. 9 and 10, *a* and *b* are two blocks or stops, to prevent the rudder from being unshipped; which are fixed to the false stern-post below the two upper braces.

Fig. 11 is a view of the upper side of figs. 9 and 10.

c c, two cheeks, one on each side, well secured to the spindle; by which means smaller timber will make a rudder, and is more easily obtained than larger.

d d, ring-bolts, one on each side, which answer two purposes, namely, for hanging the rudder, and, by crossing the chains, act as rudder pendants.

f is a chuck, to prevent ropes getting between the rudder and stern-post, and also serves as a guide for hanging the rudder, when the ship is afloat, and it likewise supports the lower brace.

g is a false stern-post, with a semicircular groove, to

receive the fore part of the rudder, which is made cylindrical; by which means the water is prevented from entering between the stern-post and rudder, which adds power to the rudder, and does not retard the ship.

h is an additional pintle, fixed at the top of the rudder, and secured by a strap of iron passing athwart-ship, which is firmly secured to the chucks fixed round the helm-post.

N° XXIII.

Woolwich Dock Yard,
Jan. 27th, 1820.

SIR;

I BEG to lay before the Society of Arts, a method which, from the long experience I have had in ship and boat building, I have no doubt would be found highly useful in replacing a rudder carried away in a gale of wind, or by other accident, a model of which temporary rudder I have the honour of transmitting with this letter.

By reference to this model, it is obvious that no stuff is required in its construction but what may be immediately supplied in men of war, from the hammock boards and the men's mess tables, together with a spare anchor stock; and in merchantmen recourse must be had to spar or yard, and any bulkhead or platform stuff, that can be the best spared for the purpose: three pintles, which must be kept in reserve, will be the only additional expense of lumber requisite to be taken on board to provide against so serious an accident, which has undoubtedly been the occasion of the loss of many a valuable vessel, and of the lives of many hundred of human beings.

I am, Sir,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.
WM. HOOKEY,
Master Shipwright's Assistant.

Reference to the Engraving of Mr. HOOKEY'S *method of constructing temporary Rudders,* Plate XXV.

Fig. 1 is a side view of a temporary rudder for a 74 gun ship, part of the planking being removed to show the manner of its construction.

Fig. 2 is a horizontal section of the above.

Fig. 3 is an edge view of the fore part of the rudder and pintles.

Fig. 4 is an edge view of the after part of the rudder.

a a, two cheeks (secured to the spindle *b,* or main piece), which it is proposed to make of the spare anchor stocks.

c c is the middle planking, which is fixed at right angles to the spindle, and which is to be made from the men's mess tables; to each side of these are fixed planks *d d,* at right angles to those of *c c,* and which are to be made from the hammock boards; to each side of these are fixed planks *e e,* in an oblique direction: on one side of the rudder the planks are directed upwards, and those on the other side downwards (which are likewise made of the men's mess tables), which prevents the rudder from racking, when secured all together with the tree-nails and nails.

f f are iron braces, which are fixed at one end to the cheeks *a a,* and the other ends are fixed to the after part of the rudder, they cross each other, and thus prevent the rudder from racking.

g g are ropes fixed to the after part of the rudder, to assist, if necessary, in steering the ship, by tackles being brought to them.

Fig. 5 is a side view of a merchant ship's temporary rudder, having part of the planking removed to show its construction.

Fig. 6 is a plan of the above.

Fig. 7 is an edge view of the fore part of the rudder and pintles.

Fig. 8 is an edge view of the after part of the rudder.

h h, the spindle, made from a spar or yard; to each side are fixed cheeks *i i*, wound tight with rope, in case there are no iron hoops on board.

j j are two thicknesses of planking, lengthways of the rudder, which may be made from any platform stuff below; to each side of these are fixed planks *k k*, in an oblique direction.

l l are scores, cut out in the wake of the braces under water.

N° XXIV.

Royal Dock Yard, Woolwich,
Jan. 24th, 1820.

SIR;

I BEG to lay before the Society of Arts, &c., the model of a machine intended to answer the double purpose of becoming a spare Topmast Cap, and for forming boats' timbers and knees, in order to repair boats when ships are at sea, or in a foreign port.

By means of this machinery, boats' timbers and knees may be made out of straight timber; they possess the important advantage of being light and strong, 38 knees being formed out of two cubical feet of timber.

I practised this method for four years while master boat-builder in Woolwich Dock Yard, and never in a single instance knew of any one breaking. With an entire confidence in the discriminating judgment of the Society, and in their liberal encouragement of every useful invention,

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. WM. HOOKEY.

Reference to the Engraving of Mr. HOOKEY'S *method of bending and forming Boats-knees and Timber out of straight Timber.*

Plate XXVI, fig. 1, is a view of the upper side of a block of wood, intended as a spare topmast-cap; in each side of which grooves are cut, to the curve and form of the knees and timber required; those on the under side of the block are represented by the dotted lines.

Fig. 2 is an edge view of the above.

Figs. 3, 4, 5, and 6, represent the knees or timbers as formed in the above block.

Figs. 3 and 4 have chucks made on different principles to form the knees.

a a are wedges, to set the knees or timbers into more or less compass.

b b indicate the place of the square and round holes which may be made in the block, for the mast-head and topmast, but they are not to be cut out till wanted.

Fig. 5 are cutters' and gigs' bent timbers, but which had been bound round with a rope yarn, when in a straight state, and were bent altogether in the groove marked *c c*, of fig. 1.

d, an end view of the timbers.

N° XXV.

Woolwich Dock Yard,
Jan. 27th, 1820.

SIR;

I BEG to present to the examination of the Society of Arts a drawing of a Chain Beam which I have projected for the purpose of strengthening merchant vessels, while at the same time it facilitates the loading and unloading in a very considerable degree, particularly of ships with cargoes of timber. As the drawing which accompanies

this letter, will render the application and operation of this beam much more obvious than any written description which I can give, I shall merely observe, that it may be taken up and replaced in a few minutes by any two sailors or labourers, by means of the screws shown in the figure; I may, however, be allowed to make a few observations on the utility which I imagine will accrue from the application of this principle. In the first place, it will be found of great advantage in stowing and unstowing the ship; 2ndly, it will prevent the cargo from shifting when the vessel is not full stowed; and 3rdly, with a full cargo it will prevent the vessel from expanding and foundering in a heavy sea, or when on shore, and gives additional strength. I beg leave farther to observe, I have fitted beams of the above description to several navy transports, which have been highly approved of by the respective captains; one of those vessels went to Pletenberg Bay, round the Cape of Good Hope, for timber; and in this case in particular, great advantage was derived from the application of the beams.

I am, Sir,

A. Aikin, Esq.
Secretary, &c. &c.

&c. &c. &c.
Wm. Hookey,
Master Shipwright's Assistant.

P. S. It is much to be regretted that in a great commercial nation like England, year after year is allowed to pass over our heads without producing any solid improvement in the construction of our merchant vessels. When we examine the melancholy lists posted daily at Lloyds, it is impossible not to reflect that many of the losses, not only in property, but of the valuable lives of our brave sailors, have been sacrificed by faulty constructions; which, if corrected, would give more confidence to our merchants to embark their property, more comfort and

security to our navigators, and save the useless tears and lamentations of many a widow and orphan. If what I have now had the honour of submitting to the Society of Arts should tend towards the attainment of this desirable end, it will be to me a source of the highest gratification.

Reference to the Engraving of Mr. HOOKEY'S *Chain Beams, for the Preservation of Ships with large Hatchways and deep Holds, without Beams, when on shore, and also when rolling in a heavy sea, and which are of very great advantage in stowing the Hold, and preventing the cargo from shifting.*

Plate XXVII, fig. 1, is a cross section of a vessel. The same letters referring to the same parts in each figure.

A A, riders of iron, with eyes forged on them, to couple the chain to; these riders are firmly fixed to the sides of the vessel with bolts.

B B, two chains, coupled to the two iron riders by means of two shackles and bolts; to the other ends of the chains are coupled, by means of another pair of shackles, two long links, one end of each having a female screw, which receives the screwed pin *c*, the opposite ends of which are formed into a right and left handed screw, in the center of which is an eye, into which is introduced a lever for turning it; which, if turned in one direction, makes the two links advance towards each other, and tighten the chain; and if turned the other way, has the contrary effect.

Figs. 2 and 3, two views of the links, shackles, and screw, to an enlarged scale. The screws are one foot long at each end; their diameters depend on the tonnage of the ship; for instance, $1\frac{3}{4}$ inch for a 400 ton ship.

D is a shifting beam or strutt, which is placed alongside of the chain, and prevents the sides of the vessel

being drawn together by overscrewing the chain; but it will depend on the sort of cargo the ship may be loading with, whether or not the wooden beams will be put in.

Fig. 4 is a plan or view on the upper side of the main hatchway, showing the manner in which it is secured by the iron straps and screws.

E E, two straps, firmly secured to the under side of the short beams F F.

G G, two pair of links and screws, similar to the one already described for tightening the chain, which are coupled to the two straps E E, by means of the open ended links and pins; two views of which are shown by figs. 5 and 6, to an enlarged scale.

Strutts are introduced in the commings of the hatchway, opposite to the ends of the beams, which prevent the chains from being overscrewed.

Fig. 7 is a plan or view from the underside of the main hatchway, being another method of preventing a ship from expanding, by two chains being frapped or drawn in *taught*, by means of a pair of double blocks, or a purchase; and two small chains passed round it, with a hook at each end, to secure the chains when drawn up.

H H, two chains, which ought first to be stretched across the vessel as *taught* as possible, and the ends be coupled to two straps firmly bolted to the sides of the ship.

I, a pair of double blocks, hooked on the middle of the chains; which, when sufficiently drawn in, are to be secured by the small chains K K.

N° XXVI.

PROPELLING SHIPS OF WAR.

The smaller or VULCAN GOLD MEDAL *was this Session voted to Captain* JAMES BURTON, *R. N., Portsmouth, for a method of* PROPELLING SHIPS OF WAR. *The following communication has been received from the candidate on the subject, and a Model of his Invention is placed in the Repository of the Society.*

Salopian Coffee House,
February 16, 1820.

SIR;

I TAKE the liberty of requesting you to have the goodness to submit to the Society for the Encouragement of Arts, Manufactures, and Commerce, my plan and model for propelling ships in a calm; and also by means of the same machinery of working the chain pumps on the principle of a water-mill, when the ship is moving through the water.

I beg to observe that it has met the highest approbation of my Lords Commissioners of the Admiralty, as well as of the numerous officers and scientific men who witnessed its trials. I inclose the official reports made thereon, and will do myself the honour of attending in person to explain the invention to the Committee. I shall be obliged to you to fix an early day for this purpose, as I am on the eve of leaving England.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. JAMES BURTON, *Captain in the Royal Navy.*

CERTIFICATES.

Ramillies, in Portsmouth Harbour,
SIR; May 12, 1819.

HEREWITH I transmit for their Lordships information, a letter from Captain Sir James Gordon, stating that a trial of the machinery for rowing the Active was made this day, and expressing a desire to make a further trial thereof, by proceeding in the ship to Spithead by the machinery, on Saturday next, or the first favourable day afterwards.

In submitting this I beg you will acquaint their Lordships that I was on board the Active during the whole of the time this trial was made; the ship was propelled by the machinery a considerable distance down the harbour, and fully sufficient, in my opinion, to ascertain its perfection and utility; and I beg to add, that I agree in opinion with Sir James Gordon, that the ship may be removed to Spithead by it without risk or difficulty, provided the tide is not too powerful (there not being sufficient water until about half flood); and if their Lordships approve thereof, I will order the trial to be made on Saturday next, or the next favourable day afterwards.

I am, Sir,

&c. &c. &c.

John Wilson Croker, Esq. A. P. HOLLIS, *Commodore*

His Majesty's Ship Active, in Portsmouth Harbour,
SIR; May 12, 1819.

I HAVE the honour to acquaint you that a trial was made this morning of the machinery for rowing the Active, which has been fitted on board, and I have great pleasure in stating that it fully equalled my expectations.

The weather was moderate with a young flood tide; one hundred and eighty men were employed at the three

different capstans, and with this force the Active was propelled through the water with a light air on the beam, and against the tide (which was running full half a knot) at the rate of nearly two miles and a half an hour; and I have no hesitation in saying, that in my opinion, under similar circumstances of weather, this ship may be propelled to Spithead by this machinery without risk or difficulty; and I should very much wish, provided it meets their Lordships' approbation, to make a further trial by proceeding in the ship to Spithead by the machinery, on Saturday next, or the first favourable day afterwards.

I am, Sir,
&c. &c. &c.

Commodore Hollis. J. A. GORDON, *Captain.*

Ramillies, in Portsmouth Harbour,
SIR; May 16, 1819.

I TRANSMIT for their Lordships' information, a letter from Captain Sir James Gordon, of the Active, detailing the particulars of the experiment which took place yesterday, of propelling that ship to Spithead, by means of the rowing machinery fitted on board; and having been present during the operation, I beg to remark that I am fully of opinion that the ship might have been taken to Spithead, but for the impediment of the wind and tide, as expressed in Sir James's letter; and having now given the machinery a fair trial, I have directed the Active to proceed to Spithead with the fair wind; and which I trust will meet their Lordships' approbation.

I am, Sir,
&c. &c. &c.

J. W. Croker, Esq. A. P. HOLLIS, *Commodore.*

His Majesty's Ship Active, in Portsmouth Harbour,
SIR; May 15, 1819.

I HAVE the honour to report to you that the weather being moderate this morning, with a light air from the southward, and deeming it practicable to take the Active to Spithead, by the rowing machinery; the moorings (which are abreast of the Prince, above the Dock-yard), were, by the desire of the pilot, slipt at 24 minutes before 11; the ship began to move in about half a minute after the capstans were set in motion, the paddle wheels at first making about six revolutions per minute; at 10 minutes past 11 the ship was abreast of the King's Stairs, going at the rate of two knots, with the wind right a-head and freshening, and the tide running in about half a knot, the wheels then making eight revolutions per minute; at 14 minutes before 12 the ship was abreast of Point, going barely two knots, the wheels making the same number of revolutions, and the wind gradually increasing, and the tide running about one knot and two fathoms by the common log: at 25 minutes past 12 the ship was a-breast of the eastern part of the platform, going a knot and a half, the wheels making the same number of motions. The tide having increased to a knot and a half, and the wind also increasing, and observing the Camelion under weigh at Spithead, I demanded by telegraph her rate of going, and received for answer, "5 miles." I did this with a view of ascertaining the probable resistance the ship met with from the force of the wind being right a-head.

The ship having been propelled thus far by the machinery against wind and tide, which were both increasing, and finding that she made but little progress, it was deemed prudent, in preference to anchoring there, to drop her into the harbour, where she now is ready to take advantage of the first fair wind to sail to Spithead.

I beg to observe that the experiment of this morning has proved in my mind the capability and utility of the machinery, which has fully equalled my expectations, and I have no doubt, but from the impediment of wind and tide, that the ship might have been taken to Spithead with safety.

I cannot, in justice to Lieutenant Burton (the inventor), close this letter without bearing testimony to his zeal, assiduity, and attention, which has been unremitted during the whole time he has been here.

I am, Sir,

&c. &c. &c.

Commodore Hollis. J. A. GORDON, *Captain.*

His Majesty's Ship Active, Halifax Harbour,
SIR; October 18, 1819.

HAVING, with the permission of the commander in chief, got under weigh, for the purpose of taking the ship round George's Island by the propelling machinery, I have the honour to inform you for the information of my Lords Commissioners of the Admiralty, that, with the exception of one or two keys dropping out which connected the rigger wheel, which was the cause of an arm giving way, it answered exceeding well, and that, when the ship was wore to return to her anchorage, she moved at the rate of $3\frac{1}{2}$ miles per hour, the paddle wheels making eleven revolutions per minute: there was a light air from the southward during the whole time the ship was under weigh.

After the last trial in Portsmouth harbour, the whole of the machinery, or rather the paddle wheels, were stowed away; and was the ship in chace and a calm coming on,

the paddle wheels could be put together and ready for working much sooner than the boats could be got out.

I am, Sir,

&c. &c. &c.

J. A. GORDON, *Captain.*

Reference to the Engraving of Captain JAMES BURTON'S *Method of Propelling Ships, and working the Pumps,* Plate XXVIII.

Fig 1 is a plan of part of a vessel, the planking of the decks being removed for the purpose of showing the machinery.

Fig 2 is a cross section of part of the vessel at the shaft which works the paddles.

Fig 3 is a view of part of one side of the vessel, showing one of the paddle wheels.

Fig. 4 is a longitudinal section of fig. 1, through the center of the vessel.

The same letters refer to the same parts in each figure.

There are three circumstances in which the application of the machinery about to be described will be found advantageous; first, in propelling the vessel when she is becalmed, or is on a lee shore, by applying the men at the capstans, as the power for working the paddles; 2nd, in working the chain pumps, by the application of the men alone to the capstans; 3rd, in the application of the paddle wheels as a power, to work the chain pumps when the ship is under sail, and in a leaky state.

a a is a horizontal shaft of cast iron, reaching across the vessel; on each end of the shaft is fixed a cast iron wheel or frame *b b*, in which are eight mortices to receive the wrought iron arms *c c*, that carry the floats *d d*, &c. of

the paddle wheels; these arms may be fixed into the mortices in the frame, by means of keys or set screws, or otherwise, as may be most convenient for unshipping them: the extremity of the floats of each paddle wheel is connected together by means of two sets of light stays or braces of wrought iron: *e e* is the ship's capstan, to the lower end of the axis of which is fixed a wheel or rigger *f f*: *g* is an additional capstan, on the upper end of which is fixed another wheel or rigger *h*, the upper face of which is formed into a cogged bevil wheel.

The power is communicated from the capstan *e e* to the capstan *g*, by means of an endless chain passing round the two riggers *f* and *h*, which chain is conducted, and prevented from swagging by the rollers *j j j* which are suspended to the beams of the vessel. The bevil wheel *i* works into the bevil pinion *k*, which is fixed on the shaft *a a* and gives motion to the paddle wheels, when the vessel is becalmed, and is intended to be propelled by the power of the men applied to the capstan bars. If the men are required to work the pumps, the pinion *k* must be thrown out of geer, by sliding the pinion endways on the shaft, and the floats of the paddle wheels must be unshipped; the pinion *l* must then be thrown into geer with the wheel *i*: on the other end of the shaft on which the pinion *l* is fixed, is a spur wheel *m* which gives motion to the two spur pinions, fixed on one end of the shafts or spindles *o o*, on the other ends of which are the riggers *p p*, that work the chain pumps *q q*.

But should the vessel be leaking more than the men at the capstans are able to keep under, the paddle wheels must be rigged out, and the pinion *k* likewise be thrown into geer with the wheel *i*, by which means the pumps may be worked when the vessel is under sail, by the action of the paddle wheels alone, as a power, without the

assistance of any men at the capstans, or if the ship's way is not sufficient, the men may also be employed at the same time.

N° XXVII.

SAFE COACH.

The Gold Medal *was this Session voted to Mr.* Obadiah Elliott, *of Westminster Road, for a* Safe Coach. *The following communication on the subject has been received from the candidate, and a Model of the Coach is placed in the Repository of the Society.*

Westminster Bridge,
Feb. 23rd, 1820.

SIR;

In submitting to the consideration of the Society for the Encouragement of Arts, &c., my new invented Life Preserver or Safe Coach for travelling, I beg to be indulged in a few observations, and at the same time to solicit, should it really be found deserving thereof, the honour of their patronage and approbation.

I flatter myself, upon examination, this coach will be found far superior, with all the combined advantages it possesses, to any thing ever yet introduced to their notice, as every reasonable objection that has been advanced to the generally adopted method of building stage coaches, is by this invention removed.

This coach is superior to those at present in use, not

only as it regards general safety, but is also much lighter and easier of draught, and the principal weight is placed, and the body itself, hung so low, as to render it utterly impossible to turn over, under any circumstances however unfavourable.

It is easier of draught by the proportion of more than one horse to four, which proceeds from two causes; first, that, whereas the fore wheels of the coaches now used, erroneously termed safety coaches, are but 2 feet 8 or 10 inches high (which instead of diminishing the labour, does absolutely require, and particularly in wet weather, the additional power of two horses, while they wear out a pair of wheels in one week); my fore wheel is nearly as high as the hind one, and the coach itself it shorter by 14 inches, than any other. Secondly, it is lighter by above 3 cwt., though I have made very large wells for luggage (larger than is perhaps requisite), on account of the whole of the perch, carriage, iron work, &c., being entirely dispensed with.

With regard to safety, the first advantage peculiar to this coach alone, is, that the front part in which the outside passengers and coachman are seated locks round, so as to be always in a right line with the horses; hence those accidents will be prevented which but too frequently occur, from a sudden start or turn to the right or left.—Further, it is so contrived, and the springs are so fixed, that if one or all were to break at once, the body would drop but a few inches, and could, without inconvenience, proceed on the remainder of the journey.—Again, if the axletrees were to break, and all the wheels come off, the body would fall but 18 inches;—or, which is much more probable, should, either the fore, or hind wheel, or both, by neglect of proper attention, come off, the center of gravity is so near the center of action, that the body would only fall on an

incline of 7 or 8 inches at most, and could not possibly overturn.

In this coach, all the lesser conveniences and comfort so desirable, are also attained, and the most infirm persons will not experience the least difficulty in getting out of and in their places.

For the practical proof of the above observations I can answer, as I have built a coach at very considerable expense (which may be seen at my manufactory), and in trying the experiment with the hind wheel off, found it required the strength of five men to turn the body on its side, which, from the revolving system of its construction, was done while the front part remained stationary and unincon-venienced.

With respect to the mode more generally adopted within these few years, of fixing the luggage underneath, I beg leave to say, that as for nearly 20 years I have been in the habit of fixing to the bottoms of all the carriages I have built without a perch, luggage boxes or wells, which I term sub-imperials, I hope I may be permitted to claim, as peculiarly my own, the origin of that method, since applied by Mr. Milton to the Reading and other coaches, under the idea of improvement.

I am, Sir,

&c. &c. &c.

OBADIAH ELLIOTT, *Coach-Maker.*

Reference to the Engravings of Mr. OBADIAH ELLIOTT'S *Safe Coach.*

Plate XXX is a view of the coach with one fore-wheel off, and only 8 inches out of level, showing the impossibility of an overturn.

Plate XXIX, fig. 1, is an elevated view of the coach;

a, the body carrying four or six inside passengers, with an entrance door *b* at the back; *c*, the front boot for luggage; *d d*, the seat for ten or more passengers, connected to the body by a sliding rod *e*; *f*, a safe step; *g*, a private box in the foot board *h*; *i*, the hind luggage box or boot, with a groove or opening *k*, cased in the middle for the axletree to slide up and down in; *l*, a safe step; *m*, the iron straps which fasten the front boot to the elliptical springs; *n*, the iron strap securing the body and hind boot on the springs: the shackles *o o o o* are immoveably fixed to the ends of the bottom springs; the front springs are inclined two inches, and the hind ones one inch, their front ends being highest to counteract the concussion met with on the road.

Fig. 2 is a sectional view of fig. 1; *p q*, the seats inside; *c c*, the front boot, of $\frac{3}{4}$ inch board dovetailed and trussed together; *d d*, the front seat outside; *e*, the sliding rod, fastened to a wooden cross-piece *r* in the front boot, with iron bearings *s*, on the locking plate *t*; the rod passes through and revolves in three collars or bearings in the body *a*, and is secured with a nut and key at *v*; *h*, the front half of the hind luggage box opening at *u* from the inside of the body; *k*, the groove, up and down which the axletree plays; *i*, the other half of the luggage-box, with a door at *w* to open behind; the hanging step at *w* turns up to let the door open; *x*, seats behind for two or more passengers; *y*, a stay bolted on the cross piece *r*, and supporting the coachman's seat *z*.

Fig. 3 is a bird's-eye or ground view of fig. 1, showing the manner in which the front part locks round; *d d*, the front seat; *c*, a lift-up or trap door to the front part of the boot; *q q*, two angle doors (which can be made in one) to the hind part of the front boot; *r*, the cross piece to which the sliding rod *e e* is fastened: the iron bearings are shown by the dotted lines *s s*, and the locking plate by the dotted line from *t* to *t*, under the seat; *v*, the nut and key of the sliding rod under the seat rail in the body.

Fig 4 is a view of the front seat rail of the body and the iron stay with a solid collar *v*, in which the revolving sliding rod is secured.

N° XXVIII.

SUN-DIAL.

The large SILVER MEDAL *of the Society was this Session voted to Mr.* GRIFFITH DAVIES, *teacher of the Mathematics, Cannon Street, London, for a* SUN-DIAL. *The following communication has been received from the candidate on the subject.*

43, Cannon Street,
December 8, 1819.

SIR;

I HAVE constructed a Sun-Dial of a peculiar description, and engraved it on a Welsh slate, 27 inches square and an inch thick.

If such should come within the object of the Society of Arts, &c., I shall feel happy in bringing it for their inspection at any time they may think proper to appoint.

I am, Sir,

A. Aikin, Esq. &c. &c. &c.
Secretary, &c. &c. GRIFFITH DAVIES.

THIS dial, of which plate XXXI is a reduced drawing, by the shadow of one gnomon shows the following particulars, viz.

1. The hour of the day at London.
2. The hour of the day at Pekin.
3. The sun's place in the ecliptic, and the curves traced out, by the shadow of the summit of the gnomon, at the

entrance of the sun into each of the 12 signs of the zodiac.

4. The day of the month.
5. The sun's declination.
6. The time of sun's rising.
7. The time of sun's setting.
8. The length of the day.
9. The Babylonish hour, or time from sun's rising.
10. The sun's altitude.
11. The sun's azimuth.
12. The equation of time to mean noon.
13. The day and hour when the sun is vertical at several places, situated between the tropics.
14. The proportional quantity of solar rays falling obliquely on a given surface, as compared with the quantity falling vertically on a like portion of surface.

As works on dialling contain directions for constructing sun-dials to show all these particulars, excepting the last three, the inventor submits his dial to the consideration of the Society, more on account of its novelty as a work of art, and the lowness of the price for which such dials may be engraved on slate as compared with brass, than for any peculiarity in the theory of its construction.

For the benefit of such as may be disposed to construct similar dials, the candidate has furnished the Society with the following sketch, which is partly an elucidation of the particulars before mentioned, and partly descriptive of the methods by which they were delineated.

The gnomon is made of solid brass, and is fixed to the slate by two legs, which are fastened underneath by screws. The dial is to be placed horizontally, so that the upper edge of the gnomon may be parallel to the earth's axis; and, for the sake of illustration, that side of the dial on which the shadow falls in the afternoon is denominated the right side, and the other the left.

1. The hour of the day at London is shown by the shadow of the upper edge of the gnomon falling on the diverging lines, which are numbered on the interior circular line surrounding the gnomon, plate XXXI: the morning hours from 6 to 12 by the shadow of the *left* edge coinciding with the diverging lines, which issue from the point, and the afternoon hours from 12 to 6 by the shadow of the *right* edge coinciding with those diverging from the point. The hours before 6 in the morning and after 6 in the evening are shown by the shadows of the contrary sides of the gnomon on the continuation of the lines, which exhibit the hours respectively 12 hours distant from them.

Writers on dialling have demonstrated that the hour angles on the plane of a *horizontal* dial may be found by the following proportion, viz. radius : sine latitude :: tangent 15 n° : tangent of the angle made with the meridian line, by the line showing the n^{th} hour from noon.

By this analogy the angles made by the hour lines on a horizontal dial in lat. 51° 32′ were found to be as follow:

Hour from Noon.	Angle.	Hour from Noon.	Angle.	Hour from Noon.	Angle.
$\frac{1}{4}$	2° 56′	$2\frac{1}{4}$	27° 37′	$4\frac{1}{4}$	57° 48′
$\frac{1}{2}$	5 53	$2\frac{1}{2}$	31 0	$4\frac{1}{2}$	62 7
$\frac{3}{4}$	8 51	$2\frac{3}{4}$	34 29	$4\frac{3}{4}$	66 34
1	11 51	3	38 4	5	71 6
$1\frac{1}{4}$	14 53	$3\frac{1}{4}$	41 46	$5\frac{1}{4}$	75 45
$1\frac{1}{2}$	17 58	$3\frac{1}{2}$	45 35	$5\frac{1}{2}$	80 27
$1\frac{3}{4}$	21 7	$3\frac{3}{4}$	49 31	$5\frac{3}{4}$	85 13
2	24 20	4	53 36	6	90 0

In laying down these angles on the plane of a dial, it ought to be observed, that allowance must be made for the thickness of the gnomon, by measuring the angles for

the afternoon hours from the right side of the gnomon, and the morning hours from the left.

2. The hour of the day at Pekin is shown in the same manner as the hour at London, by the shadow of one of the upper edges of the gnomon, and is marked on the exterior circle surrounding the gnomon. This line is laid down merely by converting the longitude of Pekin 116° 22′ into time = $7^h\ 45\frac{1}{2}'$, and placing each hour so much earlier than the same hour at London. In the same manner the time at any other place may be exhibited.

3. The sun's place in the ecliptic, or his entrance into the several signs of the zodiac, is shown by the shadow of the summit of the gnomon coinciding with the curves, which are drawn by strong lines across the dial from right to left; and the sun's place, when situated in any intermediate position, is marked on the lines, and discovered by the shadow in the same manner as the latitude of a place situated between two parallels on a map.

It is shown by writers on dialling that the curves traced out on a horizontal plane by the shadow of a fixed point, in any latitude below $66\frac{1}{2}$, are *hyperbolas;* and that the hyperbola thus traced on any day when the sun has a given north declination is equal, similar, and opposite to that described on the day when the sun has a like south declination. From this it follows that such curves may be thus described: let A B C, fig. 1, plate XXXII, represent the gnomon; A B E and *a b e* meridian lines, that is lines drawn parallel to and coinciding with the sides of the gnomon A B C; and let it be required to describe the hyperbolas traced out on the longest and shortest days. From the latitude 51° 32′ deduct the greatest declination 23° 28′, and there remains 28° 4′ for the sun's meridian zenith distance on the longest day; and by adding the greatest declination 23° 28′ to the latitude 51° 32′, we have 75° for the sun's meridian zenith distance on the shortest day.

Again, by spherical trigonometry we have cosine lat. 51° 32′ : sine dec. 23° 28′ :: rad. : cosine of sun's azimuth at rising 50° 12′; hence by making the angle B C D equal to 28° 4′ and B C E = 75°, we have B D and B E for the respective lengths of the shadow of the perpendicular B C, on the meridian line A B E, on the longest and shortest days; and consequently D E for the transverse axis of the opposite hyperbolas traced out on those two days by the shadow of the point C. Bisect D E in O, and make the angle E O P = 50° 12′, the azimuth at rising; then will O P be an asymptote to the required hyperbolas. From E draw the perpendicular E P, meeting O P in P; and with the center O and distance O P describe a circle cutting the line A B E continued, in F and G; then, by conic sections, F and G will be the foci. Through F and G draw F *f* and G *g* at right angles to A B E, cutting the meridian line *a b e* in *f* and *g*. In E F produced take any number of points *r r r*, and with the distance E *r* and center F, describe an arc *m*; with the same distance and center *f* describe an arc *v* on the other side of E F; and from the points G and *g* as centers, still with the same distance, describe the arcs *n* and *x*; then with the distance D *r* and centers G and *g* intersect the arcs *m* and *v*; and with the centers F and *f*, still with the same distance, intersect the arcs *n* and *x*: proceed in the same manner to find any number of points *m m m*, *v v v*, *n n n*, *x x x*, &c.; then a curve drawn through the points *m m m*, *v v v*, and another drawn through *n n n*, *x x x*, will be the hyperbolas required. This is the *principle* upon which all the lines exhibiting the sun's place on the dial are delineated; but the *method* by which they have been actually described was rendered less complicated by the construction of the following table:

Sun's Place.		Sun's corresponding Declination.	Meridian Zenith Distance.	Natural Tang. of Zenith Distance.	Sun's Azimuth at rising.	Semitransverse Axis of Hyperbolas.	Distance from Center to each Focus.	Distance from Base of Gnomon to Foci.	
								Nearest.	Farthest.
♋	30°	23° 28′	28° 4′	.5332	50° 12′	1.5994	2.499	.3664	4.6316
10°	20	23 5	28 27	.5418	50 56	1.5466	2.454	.3656	4.5424
20	10	21 58	29 34	.5673	53 2	1.4043	2.335	.3634	4.3066
☊	♊	20 10	31 22	.6096	56 21	1.2072	2.179	.3622	3.9958
10	20	17 45	33 47	.6690	60 39	.9875	2.015	.3585	3.6715
20	10	14 48	36 44	.7463	65 45	.7678	1.869	.3549	3.3831
♍	♉	11 29	40 3	.8406	71 20	.5617	1.755	.3527	3.1573
10	20	7 48	43 44	.9567	77 24	.3646	1.671	.3497	2.9923
20	10	3 55	47 37	1.096	83 42	.1782	1.622	.3478	2.8962
♎	♈	0 0	51 32	1.258	90 0	0	0		
10	20	3 55	55 27	1.452					
20	10	7 48	59 20	1.686					
♏	♓	11 29	63 1	1.964					
10	20	14 48	66 20	2.282					
20	10	17 45	69 17	2.644					
♐	♒	20 10	71 42	3.024					
10	20	21 58	73 36	3.376					
20	10	23 5	74 37	3.635					
30	♑	23 28	75 0	3.732					

The second column of this Table, marked sun's corresponding declination, is laid down from a diary for the second year after a leap year. The third column is formed with the latitude and declination as before directed. The numbers in the fourth column are the natural tangents, to radius unity, of the corresponding degrees and minutes in the third column; and if those numbers were multiplied by B C, fig. 1, the perpendicular height of the gnomon, the results would represent the distance of the meridian shadow of the point C, from B the base of the gnomon, on those days corresponding to the sun's place in the ecliptic, as marked in column 1. The fifth column, marked sun's azimuth at rising, is formed as before directed. The sixth column is formed from the fourth; thus $\frac{BE-BD}{2}=\frac{DE}{2}=$ O D or O F, that is $\frac{3.732-.5332}{2}=\frac{3.1988}{2}=1.5994$ $=\frac{3.635-.5418}{2}=\frac{3.0932}{2}=1.5466$, and so on. The

seventh column is formed from the fifth and sixth, thus, cosine of E O P 50° 12′ : O E 1.5994 : : radius : O P = O F or O G 2.499; cosine 50° 56′ : 1.5466 : : rad. : 2.454, and so on. Lastly, the 8th and 9th columns are formed from the 4th, 6th, and 7th; thus, O G — (O D + B D) = B G, and O F + O D + B D = B F, that is 2.499 — (1.5994 + .5332) = 2.499 — 2.1326 = .3664; and 2.499 + 2.1326 = 4.6316 : 2.454 — (1.5466 + .5418) = .3656 and 2.454 + 1.5466 + .5418 = 4.5424, and so on. The construction of the lines on the dial exhibiting the sun's place, by the assistance of the above Table, is as follows: .5332 multiplied by the height of the gnomon, and the result laid off from B and *b*, will give the points D and *d*, and 3.732, multiplied by the said height, and the result laid off from B and *b* will give the points E and *e* in the opposite hyperbola. Also .3664 and 4.6316 multiplied by the height of the gnomon, and the results laid off in contrary directions from B and *b*, determine the foci G *g* and F *f*, whence the hyperbolas *n x* and *m v* may be described as before directed. In the same manner the hyperbolas traced out by the summit of the gnomon on any two days, when the sun has equal and contrary declination, may be delineated. Note—when the sun is on the equator, the opposite hyperbolas coincide and degenerate into a straight line.

Conceiving the accuracy of the lines exhibiting the sun's place, to be of importance for determining the positions of several lines exhibiting other particulars, I have adopted a method of verifying this construction, by calculating the sun's altitude at different hours from noon, on the several days when the sun's place in the ecliptic is such as is marked in column 1 of the preceding Table. And having found the sun's altitude for any given day and hour, the sun's zenith distance at that time is found by

subtracting the altitude from 90°. Then by multiplying the tangent of the zenith distance by the height of the gnomon, and taking the result for a radius, with the base of gnomon as center, and drawing a circle to intersect that hour line, a point in the hyperbola will be obtained. Thus, let the one o'clock hour line A Q be produced indefinitely to K; find the sun's altitude on the longest day at one o'clock, and subtract it from 90°; take the natural tangent of the remainder, and multiply it by the height of the gnomon B C; then with the result as a radius, and with the center B, intersect A K in Q; then shall Q be a point in the hyperbola *x x n n:* in the same manner the point T in the hyperbola *v v m m* may be found.

4, 5, 6, 7, 8, the lines exhibiting the day of the month, sun's declination, time of sun's rising, time of sun's setting, and length of the day, were laid on the dial, by the assistance of an ephemeris, opposite their corresponding degrees of the sun's place in the ecliptic; and as these particulars are shown by the summit of the gnomon in the manner before described of the sun's place, they require no further explanation.

9. The Babylonians considered their day to begin at sun-rising, and to end at the following sun-rising, and they conceived it divided into 24 equal parts. Hence it is manifest that neither their days, nor the parts into which they were divided, were exactly equal; but so far as regards dialling, the difference is so small, that all their days may be considered as equal, and each of the parts into which they divided them may be looked upon, in point of duration, as equal to *one hour;* and in this light the "*Babylonish hour*" becomes synonymous with the "*time from sun's rising.*" Writers on spherics (of whom Theodosius is one) have demonstrated that the sun, at a given interval after rising, is on the circumference of the same

great circle all the year round; while those on dialling, or on the projection of the sphere, have proved that in the gnomical projection, all great circles are projected into straight lines. Moreover, supposing the earth a perfect sphere, and abstracting from the effects of refraction, it is evident that the sun, when on the equator, must rise at 6 o'clock.

Again, by spherics, rad. : tang. lat. 51° 32′ : : tang. declination 23° 28′ : sine ascensional difference 33° 7′, and $33° 7' \div 15 = 2^h\ 12\frac{1}{2}'$; then $6^h - (2^h\ 12\frac{1}{2}') = 3^h\ 47\frac{1}{2}'$ for the time the sun rises at London on the longest day; and $6^h + (2^h\ 12\frac{1}{2}') = 8^h\ 12\frac{1}{2}'$ for the time of rising on the shortest day. From these principles the Babylonish hour may be laid on a dial, in the following manner: for example; let it be required to lay down the fifth Babylonish hour:

$3^h\ 47\frac{1}{2}' + 5^h = 8^h\ 47\frac{1}{2}'$ A.M. $6^h + 5^h = 11^h$ A.M. and $8^h\ 12\frac{1}{2}' + 5^h = 13^h\ 12\frac{1}{2}'$ A.M. or $1^h\ 12\frac{1}{2}'$ P.M.

Whence, by the method of drawing the hour lines already described from the point *a*, draw the line *a h* to exhibit the time $8^h\ 47\frac{1}{2}'$ A.M., cutting *x n* in *h*, and through A draw A *z*, to show the time $1^h\ 12\frac{1}{2}'$ P.M., cutting *v m* in *z*; join B *z* and *b h*; make B *y* equal and parallel to *b h*, and *b m* equal and parallel to B *z*; join *h m* and *y z*; then shall the shadow of the point *c*, at 5 hours after sun's rising, all the year round, touch the line *h m*, while that of the point C touches the line *y z*; and *h m*, *y z* or *h i* I *z* will be the line required. The position of the line *h m* may be verified by drawing the equator S W, intersecting *h m* in U, and joining all; then if all coincide with the hour-line of 11 A.M., this affords a proof that *h m* is correctly laid down. In a similar manner all the other Babylonish hours may be drawn and verified. In my dial the shadow of the point *c*

only is made use of to show all the Babylonish hours; but it would be more analogous to the other lines to make use of the shadow of the point *c* on those parts of the lines which fall to the left of the meridian line, and that of the point C on the parts which fall to the right of that line; in that case such of the Babylonish hour-lines as cross the meridian line, must be of the form of *h i* I *z*.

10. The almacanters, or parallels of the sun's altitude were drawn by multiplying their natural cotangents by the height of the gnomon, and describing circles with the results as radii, and the foot of the gnomon as center. Thus the cotangent of $20° = 2.7475$, multiplied by the height of the gnomon B C, and with the result as a radius and the point B as a center, describe an arc L M, and with the same radius and center *b*, describe a similar arc N Y; then when the sun's altitude is 20°, the shadow of the point C in the afternoon shall touch the arc L M, or in the forenoon the shadow of the point *c* shall touch the arc N Y.

11. The azimuth lines were drawn by describing a semicircle 4, 5, 6, about the point B, and another about the point *b*, dividing each of them into 16 equal parts, and through the points of division drawing straight lines, diverging from the points B and *b*. Thus, if the arc 4, 5, = 4 sixteenths of the semicircle 4, 5, 6, and through the points B. 5 a straight line 1, 5, 2, be drawn, the shadow of the point C will touch it when the sun's azimuth is S. SW.

12. Equation of time to mean noon.

Since each degree on the equator answers to 4 minutes of time, it follows that *n* minutes of time answers to $\frac{n}{4}$ degrees on the equator. Hence rad.: sine lat.:: tang. 4 *n*°: tang. of the angle which the hour line of *n* minutes

makes with the meridian line. By this proportion the following table was constructed:

Time.	Natural Tangents.	Time.	Natural Tangents.	Time.	Natural Tangents.	Time.	Natural Tangents.
1′	.00342	5′	.01708	9′	.03076	13′	.04446
2	.00683	6	.02050	10	.03419	14	.04789
3	.01025	7	.02392	11	.03761	15	.05132
4	.01367	8	.02734	12	.04103	16	.05475

Again, by means of an ephemeris we find that when the mean noon falls 2 minutes later than apparent noon, the sun's declination is 23° 22′ S.; when 4 minutes the declination is 23° 10′; when 6 minutes, 22° 50′ &c. Whence 51° 32′ + 23° 22′ = 74° 54′, the sun's zenith distance, when the mean noon falls 2 minutes later than the apparent noon; in like manner 51° 32′ + 23° 10′ = 74° 42′, 51° 32′ + 22° 50′ = 74° 22′ &c.

Whence take any distance A D, fig. 2, plate XXXII, on the meridian line, and multiply the natural tangents in the above table severally by that distance; then lay off the results from D, on this perpendicular line D E, and from A, through the several divisions of D E, draw straight lines A 2, A 4, A 6, &c.

Again, multiply the natural tangents of 74° 54′, 74° 42′, 74° 22′, &c., by the height of the gnomon B C, and lay off the results from B towards D, which will give the points *d e f*, &c.; then through *d* draw a curve (as described in speaking of the lines exhibiting the sun's place), cutting A 2 in *a*; in like manner draw similar curves through *e f*, &c., respectively cutting A 4, A 6, &c., in *b c*, &c. Lastly, through the several points *a b c*, &c. draw a curve, which, by the shadow of the summit of the gnomon will show the mean noon; and since the apparent noon is shown by the shadow of the gnomon coinciding

with the meridian line, it follows that the difference or interval between them must show the equation of time to mean noon.

13. The method of exhibiting on the dial the day and hour when the sun is vertical at any place situated within a certain limit: I shall take as an example the Island of St. Helena.

By means of the latitude of London 51° 32′ N., and the latitude and longitude of St. Helena 15° 55′ S. and 5° 49′ W., the distance of St. Helena from London is (by spherical trigonometry—see Bonnycastle's Trig. case 8th oblique spherics), found to be 67° 39′; whence it is manifest that when the sun is vertical at St. Helena, it must be 67° 39′ from the zenith of London; and since the zenith distance and the altitude must together make 90°, it follows that 90°—67° 39′ = 22° 21′ = the sun's altitude at London at the time when it is vertical at St. Helena. Again, because the longitude of St. Helena is 5° 49′ West from London, and 4 minutes of time corresponds to each degree of longitude, it is manifest that when the sun is vertical at St. Helena, it must be $23\frac{1}{4}$ minutes past 12 o'clock at noon at London.

From what has been said, the following construction naturally arises: multiply the natural cotangent of 22° 21′ by the height of the gnomon, and with the result as a radius, and B as a center, describe an arc G H, fig. 2; then draw the hour line of $23\frac{1}{4}$ minutes P. M. intersecting G H in S, and the point S will be that on which the shadow of the summit of the gnomon will fall at the time when the sun is vertical at St. Helena. In the same manner may be shown the day and hour when the sun is vertical at any other place situated between the tropics, provided its distance from London be less than 90°.

14. The last particular enumerated on my dial, is the proportional density of the solar rays at London,

as compared with that of vertical rays. For the sake of elucidating this particular, let it be granted, 1st, that a small portion of the earth's surface may be considered as a plane; 2ndly, that all the solar rays which fall upon such surface may be considered as parallel to each other; and 3rdly, that the density of the solar rays may be considered as not in the least affected by the comparatively small difference in the distance of one part of the earth's surface from the sun, and that of another part.

Next, conceive a square portion of the earth's surface, situated at right angles to the solar rays, to be divided into 10 equal parts by straight lines drawn parallel to one of its sides, and let the aggregate quantity of solar rays falling upon each of those parts, be called a single ray. Then, conceive the straight line C P, fig. 3, to represent one of the divided sides of such a square, and the perpendiculars C Q, 11, 22, &c., to represent the divisions of the rays which fall upon it. Moreover, conceive the square to be moved about one of its undivided sides as an axis, then will one of the extremities P, of the divided side C P, describe the circular arc P Q.

From this view of the subject, it is evident that if the position of the rays remain invariable, the number of rays falling on the given square at the position C 9 will be only 9, at the position C 8, only 8, &c., and at the position C Q not a single ray will fall upon it. Since, therefore, at the position C 9, 9 rays are distributed over the same portion of surface as the 10 rays at the position C P, it follows that the density of the solar rays on the given surface, placed in the position C 9 will be only $\frac{9}{10}$, and in the portion C 8 only $\frac{8}{10}$ of that in the position C P.

Again, it is equally evident that the density of the rays on the given plane will be affected exactly in the same manner, whether we conceive the position of the rays to remain invariable, and the plane to be moved, or the plane

to remain fixed, and the direction of the rays to be changed, provided the obliquity of the rays to the plane be the same in both cases.

From what has been said, the following construction is manifest: upon C B, fig. 2, construct the quadrant B C R, and from C draw C K, C L, C 3, C 4, &c., making the angles R C K, R C L, R C 3, R C 4, &c., respectively, equal to the angle Q C 1, Q C 2, Q C 3, Q C 4, fig. 2, &c.; then will the point 3, on the line A D fig. 2, be that on which the shadow the summit of the gnomon falls at the time when the density of our meridian solar rays is to that of vertical rays, as 3 to 10; the same may be said of the points 4, 5, 6, &c. By making B F equal to the length of our meridian shadow on the shortest day, and B V equal to that on the longest day; and joining C F, C V, it will be found that the density of our meridian rays varies at different seasons of the year, from about $2\frac{1}{2}$ tenths to pretty nearly 9 tenths.

N° XXIX.

APPARATUS FOR SAVING LIVES IN CASE OF SHIPWRECK.

The large SILVER MEDAL *and* THIRTY GUINEAS *were this Session voted to Mr.* H. TRENGROUSE, *of Helston, near Truro, for his* APPARATUS FOR SAVING LIVES IN CASE OF SHIPWRECK. *The following communication has been received from the candidate on the subject, and a Model of his Apparatus has been placed in the Society's Repository.*

SIR;

I BEG through you to offer to the notice of the Society of Arts my Apparatus for preserving Lives and Property in cases of Shipwreck, together with a short printed essay on the subject. It is my wish that experiments should be tried with the apparatus in any way that the Society may think fit for their entire satisfaction; in the performance of which I shall most gladly contribute my best assistance.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. HEN. TRENGROUSE.

Of the multitudes of seamen and others who perish yearly by shipwreck, a considerable proportion are lost,

in consequence of ships getting on shore, either by the violence of the wind or by other accidents. In these disastrous circumstances the severity of their fate is aggravated with regard both to the sufferers themselves and the spectators, by the smallness of the interval interposed between security and destruction, and the seeming ease of effecting a communication between the stranded ship and the shore. Many inventions have already been proposed for this purpose; but having been brought into practice either very partially, or not at all, have failed of producing the benefits anticipated by the too sanguine benevolence of their authors.

Captain Manby's apparatus, although resembling Mr. Trengrouse's in some particulars, is both less portable and less likely to succeed in actual practice. The initial velocity of a ball or shell is so great as to make it by no means easy, under the most favourable circumstances, to supply the cord attached to the ball with sufficient expedition: whereas, the flight of a rocket being not only much slower on the whole than that of a cannon ball, but not immediately acquiring its utmost velocity, the risk of breaking the cord is greatly diminished.

From experiments made at Woolwich before lieutenant-general Ramsey and a board of officers, in conjunction with rear-admiral sir C. Rowley and two captains in the royal navy, it appears that a rocket of 8 oz. with a mackerel line attached to its stick ranged to the distance of 180 yards, and that a pound rocket in similar circumstances ranged 212 yards. Experiments made for the same purpose by the Society of Arts, demonstrated that a rocket $1\frac{3}{4}$ inch in diameter will carry a cord completely across the Serpentine river in Hyde Park. Now the shortest of these ranges exceeds the distance of many stranded ships from the shore, especially on a rocky coast, and therefore ascertains the probable utility of Mr.

Trengrouse's apparatus on a multitude of occasions, particularly within the limits of the British Channel, the great thoroughfare for shipping of every description.

Explanation of the Engravings of Mr. TRENGROUSE'S *Apparatus*, Plate XXXIII.

Fig. 1 represents a chest containing the whole of the apparatus with which it is proposed every vessel should be furnished; its internal dimensions are 4 feet 3 inches, by 1 foot 6 inches, and 1 foot 8 inches deep. The lid forms a case for containing eight or twelve half-pound rockets, laid alternately the heads each way; to accommodate which, the two lids which cover them are deeper at their outer extremities, and are secured by thumb screws; one of these is shown open. The body of the chest is divided as described at fig 7. N° 1 contains a musket to be used merely for directing and igniting the rocket. The gun being charged with a small quantity of powder without wadding, a copper instrument, shown fig. 2, is attached to the barrel by a bayonet catch, for the purpose of receiving the head of the rocket, the stick lying along the top of the barrel, and having secured to it one end of a coil of small line deposited in the compartment N° 2 of the chest. The explosion of the powder having only the effect of lighting the rocket, it burns for a few seconds before it requires sufficient momentum to quit its situation, during which time the combustible matter would be ejected into the barrel of the gun, but for the following contrivance: at the junction *a*, fig. 2, of the large and small portions of the copper instrument, a valve is loosely hung on a joint, which opens to permit the passage of the charge, but immediately closes, and pre-

vents the barrel being choked by the discharge from the rocket. The small line being thus conveyed to the shore, one end of a small cord (vide fig. 1, and N° 3, fig. 7) is fastened to it, which the persons on the rock or beach will haul to them, and which will in similar manner convey a hawser, secured at one end to the mast, and at the other to any convenient object. The communication now being effected, a small light chair, fig. 4, and a life spencer, fig. 6, which occupy the space N° 4 in the chest, are to be taken out, and the former attached to the hawser by two rollers, one of which is seen on a larger scale in fig. 5. For more conveniently applying these rollers, the hook which is in two parts, on withdrawing the screw *b*, opens on the joint *d*; it may then be put over the hawser, and the chair attached, the small bar *c*, turning on a joint *e*, preventing the chair from being disengaged: the whole is then clamped together by the screw *b*. The small cord *f*, fig. 4, which is used for drawing the chair to and from the shore, is the same which is used for hauling the hawser; it is of course requisite that the length of this cord should be at least twice as much as the distance from the vessel to the shore. Previous to placing a person in the chair, it is proposed that he should put on the cork spencer, fig. 6, formed of ribs of cork sewed in a canvas case, and fastened by a strap and buckle, to prevent him from being immersed in the waves from the swagging of the hawser, or wounded by floating pieces of wreck. The spencer is to be returned to the vessel with the chair. Fig. 3 is a piece of wood 12 inches long, and at the larger end 2 inches in diameter, for the purpose of winding the balls of line thrown by the rocket; the small end to be held in the hand while the line is wound round the other.

The case in which are the two balls of small line slides up, and beneath are deposited two balls of line rather stronger, to accommodate rockets of different sizes, which

must be used according to the distance from the shore. The two cases 5 and 6 also slide up, and discover a water-proof canvas bag, in which papers of any kind may be secured and committed to the waves.

In N° 5 is a ball of hard wood, about four inches diameter, one half painted black and the other white, attached to a few fathoms of small line, to enable persons in a boat (throwing the ball by hand), to form a communication with individuals at a short distance, or on a rock.

In N° 6 are placed a powder-flask, flints, gun-worm, picker, a bottle of fine oil, &c.

N° XXX.

DETACHED CLOCK ESCAPEMENT.

The large GOLD MEDAL *and* FIFTY GUINEAS *were this Session voted to Mr.* WM. HARDY, *of Wood Street, Cold-bath Fields, for a* DETACHED CLOCK ESCAPEMENT. *The following communication has been received from the candidate on the subject, and a Model of his Invention is placed in the Society's Repository.*

5, Wood Street, Coppice Row, Cold-bath Square,
April 25, 1820.

SIR;

I HEREWITH send you a drawing and description of a new Escapement for a Clock, and beg you will lay it before the Society for the Encouragement of Arts, &c. Before I describe the principle on which it is constructed, allow me to mention one circumstance which I think deserves to be taken notice of. This escapement, in the

first instance, was applied to a clock which had been going with the common dead beat pallets. Having ascertained the arc of vibration of the old escapement, I removed it, and applied the new one; and having adjusted the force of the two springs (which give the impulse to the pendulum), to that of the maintaining power before applied, I set the clock a going, when I soon found the pendulum to have increased on its arc, from 4 to nearly 7 degrees. I then reduced my pallet springs to nearly one-half their strength; and yet with all this reduction of power in the springs, the pendulum still vibrated as far as it did with the old escapement when the whole of the maintaining power was applied. By this experiment is shown the great influence which the resistance of the dead beat pallets and crutch pivots have on the pendulum; and also proves that nearly one-half of the maintaining power is lost on the clock from this cause. The result of this experiment gave me great hopes of success. I therefore prepared the clock with a mercurial pendulum, in order to make trial of it at the Royal Observatory; and having written to the Board of Longitude on the subject, they referred the matter to the late Rev. Dr. Maskelyne, who very readily undertook the trouble of giving it a thorough trial. He accordingly called on me the day after the meeting of the Board, to see the escapement; and being pleased with it, desired me to send the clock to the Observatory for trial, as soon as I possibly could. It was from the satisfactory performance of this clock, that I was recommended by the Doctor to the Board of Ordnance as a fit person to furnish a clock on the same principle for the room in which the famous mural circle is placed, which circle was then making by the celebrated Edward Troughton. The order for the clock was unlimited in price, and directed me to consult the Doctor on every particular connected with it. I therefore waited on

the Doctor to receive his instructions; his treatment to me was kind and hospitable, and he gave me every encouragement to exert myself, and to complete the clock in such a manner as to be durable and certain in its performance. As it was to accompany one of the most excellent instruments that ever was made, he wished the clock to be equally so in point of excellence. This excited me to use my utmost exertion, and to spare neither time nor expense in order to make it as perfect as possible. It was decided upon to jewel every action in the escapement and all the pivot holes. The teeth of the wheels and pinions were epicycloidal, and were all finished in the engine by cutters which I made for that purpose; and the whole of the clock was finished in a style equal to any of our first-rate chronometers. The Doctor being sensible of the great importance of fixing up the clock upon a material that should be permanent and immoveable, I suggested that it should rest upon a strong brass plate screwed fast to the top of a stone pier, in which a recess or channel might be cut out to receive the weight and the pendulum, which was adopted. I cannot here refrain from saying a few words to the memory of the late Rev. Dr. Maskelyne. My first knowledge of the Doctor was at the period above mentioned; at that time they were making great improvements at the Observatory, which engrossed the whole of the Doctor's attention; the room for the new instruments was then building, and such was his perseverance, that he was out there in the most inclement weather, superintending the workmen, which I believe tended much to shorten his days: he was most indefatigable in his application to the interest of the Observatory, no doubt, for the great end of advancing the science of astronomy, in which he delighted. His attention to the business of the Observatory was punctual and strict, and he continued to transact it till within a week or two of his death, an event which, it

will be allowed, was a great loss to the public, and to be regretted the more as he did not live to see the new instruments completed, in which he took such pride, and which he strove so much to accomplish.

I am, Sir,

A. Aikin, Esq., &c. &c. &c.

Secretary, &c. &c. WM. HARDY.

Reference to the Drawings of MR. HARDY'S *improved Clock Escapement, as applied to a Regulator.*

Plate XXXIV is a view of the back part of the clock without its case, having the middle part of the back plate removed, as represented by the two fractures, to show the train of wheels; the lower part of the pendulum rod being also removed, as is shown by the fracture: the pendulum is represented as when at rest.

Plate XXXV is a side view of the clock from the left-hand side of the plate XXXIV, having the back plate complete, and the pendulum rod as far as the limits of the engraving will permit.

Plate XXXVI shows a detail of the various parts of the escapement, together with a front view of the dial-plate, &c., and the manner of suspending the weight.

All the parts of the clock are drawn to the full size, except plate XXXVI, figs. 16 and 17, which are to $\frac{1}{4}$, and fig. 18 to $\frac{1}{2}$ the whole size.

The same letters and figures refer to the same parts in the plates XXXIV, XXXV, and XXXVI.

A A, plate XXXV, represents the edge of a horizontal brass plate, which must be fixed on two brackets firmly screwed to a stone pedestal or wall, and quite independent of any part of the case of the clock. In the back part of

this plate is a slit for the motion of the pendulum, and also one for the cord to pass through, which suspends the weight, and this cord I recommend to be of silk. On the upper side of the plate A A are fixed the two frame-plates B and C of the clock, by means of the four brackets D D, &c., which are fixed to the frame plates by the screws E E, &c., and to the plate A by the screws F F, &c. The frame plates B and C are kept parallel to each other by four pillars G G, &c., and are secured by the six screws H H, &c., and the two screws E E. The dial plate is kept parallel to the front plate B, by means of the four pillars J J, &c.; one end of each is screwed into the plate B, and the other end passes through the dial plate I, and is secured by the four screws K K, &c. To the upper end of the frame plates B and C is fixed (by the two screws M M) the cross or suspension bar L L, which carries the pendulum. N is the barrel on which the cord is wound that suspends the weight, and is supported by its axis in the frame plates B and C; the end of the axis which comes through the plate B also passes nearly through the dial plate, and has a square end, which fits the key for winding up the weight. P is a spring which is fixed on the outer end of the barrel, to the side of the spring next the barrel, and near one end of it is attached a stud Q, equal to the diameter of the cord, which passes freely through the end of the barrel. The upper side of the stud is bevelled off so as to form an inclined plane with the upper side of the barrel. On the other side of the spring, opposite the stud Q, is formed a catch, which lays hold of the stop R (and which is fixed to the frame plate B), when the spring is thrown out. When the barrel is filled with cord, the last coil will act against the inclined end of the stud Q, and throw out the spring P, so as to catch the stop R, and prevent the cord from being over-wound. On the other end of the barrel

is fixed a catch wheel S (plate XXXIV); and before the wheel S, on the axis of the barrel, is fitted the catch wheel T, the middle part of which forms a flat plate to which the arms and rim are attached; on the back part of the plate are fixed the two catches U U (pl. XXXIV), which act in the catch wheel S and prevent the weight from running down without turning the wheels T V and X. On the end of the axis of the barrel is also fitted the wheel V close to the wheel T: on the outside of the plate of the wheel T are fixed two springs Y Y which act against two of the arms of the wheel V, and tend to keep it in motion and in the same direction as when the weight turns the barrel. This spring only acts at the time when the barrel is in the act of winding up the weight, so that no time will be lost; Z is a catch which acts on the upper side of the catch wheel T, and prevents the wheel T from being turned in the direction of the barrel when the barrel is in the act of being wound up. The wheel X is fixed to the arms of the wheel V by three screws, and acts in the wheel *a*, the axis of which carries the hour-hand; the wheel V acts in the pinion *b*, which is fixed on the axis of the wheel *c*; the axis of the wheel *c* carries the minute hand; the wheel *c* acts in the pinion *d* on the axis of which is fixed the wheel *e*; the wheel *e* acts in the pinion *f* on the axis of which is fixed the escape wheel *g*; this axis also carries the seconds hand. One end of the axis is supported in a jewelled hole in the cock *h h*, and the other end is supported and passes through a jewelled hole in the frame plate B. The pivots of the axis of the wheel *e* and pinion *d*, are rounded a little at their ends, and touch or bear against two cocks 20 20, which are secured to the frame plates B and C by screws and steady pins, thus rendering shoulders unnecessary, and, consequently lessening the friction thereof: the holes in the frame plates for these pivots are also considerably

widened inside, so that the oil naturally flies to the ends of the pivots, and constantly lubricates them, the cocks being purposely filed away, clear of the plates B and C. A similar precaution is likewise taken with the back pivots of the great wheel V, and the center wheel *c*.

My attention had long been directed to the principles on which the various watch and clock escapements have been constructed, when I undertook, by way of experiment, to vary several of the constructions in such way as I thought might best answer their respective purposes; and of the numerous plans that suggested themselves to me for an improved clock escapement, I selected the one which forms the subject of this communication, as most likely to succeed; fortunately I have not been disappointed in this expectation. The figures contained in plates XXXIV, XXXV, and XXXVI, will explain the principle, the construction, and also the action of the escapement, which I beg leave to describe for the consideration of the Society, to which I am already indebted for several premiums; and as this escapement has undergone a most satisfactory trial, not only at Greenwich, but in other public and private observatories, I feel a certain degree of confidence that its claim to public attention will be considered as well founded.

The upper ends of plates XXXIV and XXXV show the entire escapement with all its parts in their proper places in connection with the train. The construction of the several parts of the escapement will be better understood by referring to plate XXXVI. Fig. 1 represents a back view of the escapement wheel, together with its cock and appendages, and the two spring detents *i* and *j*: the wheel is represented as locked by the detent *i*; *k k* are two small cocks fixed on the upper side of the cock *h h*, having an adjusting or banking screw *l* in the upper end of each, which acts against the underside of the spring

detents *i* and *j*, and prevents the detents from locking too deep in the escape wheel.

Fig. 2 is a view of the upper side of the cock *h h*, without the two small cocks *k k*.

Figs. 3 and 4 are side views of the spring detents *i* and *j*.

Fig. 5 represents a back view of the escapement wheel, and the two spring pallets *m* and *n*, having the two arms of the spring detent removed ; but the locking parts *i* and *j* are shown in section in their proper places, when the wheel is locked by the detent *i ;* on the upper part of the detent *i* and on the under part of the detent *j*, are fixed two jewels, which act against the face of the teeth.

It may be observed here, that the faces of the teeth above and below are at equal distances from the under side or jewelled part of the detent *j*, consequently the drop or motion of the wheel will be equal to one-half of the space between any two of the teeth, when the wheel is unlocked by each vibration of the pendulum. When the wheel is locked by the detent *i*, the end of the tooth *o* will have slid along the face of the pallet *m*, and have raised it to its greatest extent, and the end of the tooth *p* will be ready to act on the face of the pallet *n*.

Figs. 6 and 7 are side views of the two spring pallets *m* and *n : q*, figs. 8 and 9, are a back and an edge view of an adjusting plate, which must be fixed to the back part of the frame plate *c*, under the bar L. Fig. 10 is a back and fig. 11 a side view of the triangular cock *r*, to which the two spring detents and the two spring pallets are fixed by the four screws *s s s s*, and the strengths of the springs are adjusted by the four screws *t t t t*, which screw into the upper ends of the spring detents and pallets, and act against the cock *r :* this cock is fixed to the plate *q* by the screw *u* (plates XXXIV and XXXV), which passes through the slit in the lower part of the cock, and screws into the plate *q*. On the back part of the cock *r* is fixed a

stud *v*, which passes through the slit in the upper end of the plate *q*, by which means the cock *r*, together with its appendages, may be adjusted so as to make the drop or motion of the wheel equal, during each vibration of the pendulum.

Fig. 12 exhibits a back view of the upper portion of the pendulum, with a cross bar *w w*, attached at right angles to it, which is used for the double purpose of receiving the impulse of the maintaining power, and of unlocking the detents. Fig. 13 is a view of the upper side of the cross bar *w w*, and a section of the pendulum rod opposite to it. The two ends of the bar which receive and give the impulse to the two spring detents and the two spring pallets are projected forward so as to be in a line with the center of gravity in the pendulum.

Fig. 14 is a side view of the upper part of the pendulum, without the cross bar *w w*.

Fig. 15 is a side or end view of the cross bar *w w*; *x x*, fig. 14, is the upper part of the pendulum rod, having a notch or recess in the back part of it to receive the cross bar *w*, which bar *w* has a slit opposite the center of the pendulum to admit of the bar being slid to the right or left, and through which the screw *y* passes and screws into the pendulum rod fixing the bar in the situation required: *z* is a piece of spring plate, which connects the pendulum rod to the suspension piece 1, which is fixed in a slit in the end of the cross or suspension bar L L, by the screw 2 (plates XXXIV and XXXV.) Fig. 16 represents a front view of the dial plate, and the manner of suspending the weight. The lower circle 3 is divided into 24 hours, the great or outer circle into 60 minutes, and the upper circle 4 into 60 seconds; so that the time will be exhibited by their respective indices or hands at the same instant. The dotted circle N represents the end of the barrel; 5 5 is the cord, one end of which is fixed to the

under side of the plate A A, the other passing under the pulley 6 (which works in a recess in the upper end of the weight *o*), through the plate A, is fixed to the barrel N, by which means the weight will be raised to a greater altitude than if the pulley had been fixed above the weight.

Fig. 17 is a view of the upper side of the weight *o*.

Fig. 18 represents an end view of the barrel N, and the spring P which prevents the cord from being over-wound as before described.

It will probably appear, on a superficial view of these figures, that my escapement greatly resembles some others that have been previously contrived, such as those by Mr. Cumming, Mr. Massey, and Mr. Prior, some of which have been rewarded by this Society; but the detail which I have to offer in explanation of the properties of mine, will prove that its mode of action is very different, and as I think, very superior; which is my reason for laying it before the Society.

This escapement is one of that species which has been called *remontoir*, because a spring is raised or put into a state of tension by means of the train, at each vibration of the pendulum, which spring, in its return, gives the necessary impulse for perpetuating the vibrations in spite of friction and other obstacles, and therefore becomes the *maintaining power*, while the weight that actuates the train, performs no other office than putting that spring into a state of tension.

In a clock escapement, where the pendulum is the regulator, the alternate vibrations made in opposite directions require two such springs to act by turns, and in such a modified way as to produce their desired effect with the fewest disadvantages. In the figures of all the different plates, the two interior springs marked *i* and *j*, are called the spring detents, because they detain the wheel during some portion of each vibration, and the two exterior ones

m and *n*, are called the spring pallets, because they carry each a separate pallet, by means of which the springs themselves are raised into a state of tension, as often as a tooth of the pallet wheel *g* slides along them respectively. The wheel with a seconds pendulum has, as usual, 30 teeth, standing with a small inclination, as represented in the figures, and the direction of motion is indicated by the said inclination. At *r*, fig. 10, is a triangular cock, fixed to the frame in such way that its lowest angular point is in the same horizontal line with the point of suspension of the pendulum; and to the two sides of this triangular cock are made fast the two pair of springs, by means of four screws, as seen clearly in the figures; and as the springs all yield at the said triangular point, it is evident that when any of the four springs moves, it must move concentrically with the moving pendulum, which is fixed to the suspension piece 1. On the upper side of the arm of the spring detent *i* and *j*, is formed a projecting boss, through which a cylindrical hole is made, to receive one end of the locking pins or detents *i* and *j*, which are jewelled and fixed by the screws 7 7, the faces of the jewels being previously adjusted for catching a tooth of the escape wheel. At the lower extremities of the two spring detents *i* and *j*, and the two spring pallets *m* and *n*, are fixed fast four long brass pins 8, 9, 10, and 11, all of which, both side-ways and in front, are clearly seen: these pins project out past the end of the cross bar *w* of the pendulum, in a direction parallel to the arbor of the escape wheel; and when the pendulum *x x* is in its place vibrating, the ends of the cross bar *w w*, carried by the pendulum, meet with and knock against each pair of pins alternately, and are in succession in a situation to be re-acted on after each vibration is completed: the ends of the cross bar *w w* are bevelled, so as to form a radial line from a center in the upper part of the spring *z*, which is opposite a hole 12

in the spring: this hole, made for the purpose of reducing the strength of the spring opposite to it, will be the center of vibration of the pendulum: a small hole 13 13 is likewise made in each of the two spring detents, and two small holes 14 14 in each of the two spring pallets, which will also reduce the strength of the springs opposite to each of them, and which will be the center of motion on which the springs vibrate: these parts of the springs must be placed in a radial line between the center of vibration of the pendulum and the end of the cross bar *w w*, so that when the ends of the cross bar *w w* act against the pins 8, 9, 10, or 11, there will be no motion or friction between the pins and the ends of the bar. Lastly, at 15 in the pendulum rod above the cross piece *w w*, is a stud with a single tooth, which acts in a corresponding notch 16, on the upper edge of the said cross piece *w w*, and may be moved to the right or left by means of a key or lever which accompanies the clock; so that the clock may thus be put into exact beat, or meet with the pins 8, 9, and 10, 11, at equal arcs of vibration, counted from the point of quiescence; and when the adjustment is once made where the clock is firmly fixed, the situation of the cross piece *w w* is rendered permanent by the fixing screw *y*, which may be turned by the same key.

After this minute description of all the acting parts of the mechanism, it will not be difficult to understand the nature of their action: suppose the pendulum in its place, and put into beat by the adjustment of the cross piece *w w*, let the weight be suspended in the usual way, while the pendulum is at rest; then the impulse given to the pallet or escapement wheel will bring the nearest tooth in contact with the pallet *m*, which it will raise a small space, in sliding along its face, till the preceding tooth falls on the locking pin of the detent *i*, in which situation all motion will cease; the tooth which raised the pallet *m* not having

escaped; the pendulum then being in vibration towards detent *i*, the end of its cross piece strikes against the two pins 8, 10, of the detent and pallet springs; the former is first struck, and the detent *i* being on the same spring, is now discharged, and the wheel is unlocked, and consequently at liberty to run on by means of the force applied through the train of wheels; but pin 10 is also struck at the same instant, and the wheel escapes from the pallet on which it before rested; at this instant while the pendulum goes on to complete its vibration, in opposition to the united forces of both the springs *i* and *m*, a tooth at the opposite side of the wheel meets with the face of the pallet *n*, and throws it outward, by sliding along it till the preceding tooth falls on the detent *j*, when the wheel is again at rest, with the acting tooth *p* supporting the pallet *n* in the same way as pallet *m* was before supported: presently the pendulum having made its excursion, returns, and is now impelled by both springs acting on the end of the cross piece *w w* during the whole of the return, till the detent *i* meets with the end of the banking screw *l*, which stops it: but the pallet spring *m* continues its action somewhat longer, till it falls on the end of the tooth 17, at the lower end of its plane: here the pendulum wants upwards of half a degree yet to descend, before it reaches the lowest point, where the velocity and consequently where the momentum is a maximum: after having passed this point, the pendulum will proceed somewhat more than half a degree in its ascending arc in a free state, before the other end of the cross piece *w w* strikes against the pin 9 of the spring detent *j*, and almost immediately after against pin 11 of the pallet spring *n*; this stroke will unlock the detent *j* and suffer the wheel again to escape, and while the pendulum is finishing its alternate vibration, in opposition to the united forces of both the springs *j* and *n*, the tooth next succeeding the tooth 17 that commenced

action, will in its turn raise pallet *m* until the next before it falls on the detent *i* again, and stops the wheel; in the mean time the second excursion is completed and the pendulum returns, urged by the united forces of both the springs *j* and *n*, until the banking screw *l* arrests the motion of the detent *j*, and then the pallet spring acts alone for a short time, till the lower end of its plane falls on a tooth as was before described. Thus, when the pendulum is once put into motion so as to vibrate nearly two degrees at each side of the lowest point, it will continue to unlock the detents alternately, and to have its motion successively retarded in the ascent, and accelerated in the descent, as long as the force continues in action by which the pallet wheel is made to raise or throw out the pallet springs; that is, until the clock wants winding up. After this description of the action of my escapement, it may be asked, perhaps, how does it appear that the pendulum will not come to rest, since the weight which usually constitutes the maintaining power with the dead beat and recoil escapements, is here quite detached from the pendulum? I answer, that as the pallets *n* and *m* are both in their turns moved a little from their state of rest by the action of the teeth on their planes as the wheel revolves, the pallet spring does not oppose the ascent of the pendulum through so great an arc as it impels it in its descent, and the *difference* of duration of those two opposite actions or forces *maintains*, or keeps up the loss of force experienced from friction at the suspension, resistance of the air and other retarding forces. The detent spring, however, accelerates and retards in each vibration precisely the same quantity.

I come lastly to say a few words on those properties of my escapement, which I conceive to be peculiar to it, and which in my own estimation constitute its excellence.

I first take for granted, what has been experimentally

determined by men of science, that the action of any uniform spring on a pendulum, moving in cycloidal or small circular arcs, is analogous to the effective part of gravity; and that therefore when such a spring is made to act conjointly with gravity, the effect produced by their joint actions, considered as an accelerating force, will be of the same nature as would be produced by one of them applied separately: the scale of acceleration or retardation will remain the same. Again, I assume that when any extraneous impulse is suddenly applied to a moving pendulum, the natural law of its motion depending on gravity, is least disturbed when it is applied to the lowest point, where the momentum is a maximum, and most at the extremity of the excursion, where the momentum is a minimum; and what is true of an impulse given, is equally true of a check received, or retarding force suddenly applied. Now, in my escapement the action of the springs begins and ends, not indeed exactly at the lowest point of the total arc of vibration, but within about half a degree of it, and as this distance depends on the length of the cross piece *w w* of the pendulum, it might be made still smaller without coming at the practical limit. As my pendulum is actuated, the vibrations are uniformly steady throughout; and while the clock has power to raise the pallets at each vibration, it will not cease to perform, when duly adjusted for beat.

Secondly, the force of the pallet and detent springs can be increased or diminished to suit the momentum of the pendulum used, by means of the four screws *t t* and *s s*, that fix these springs to the triangular cock; the screws *t t* being tapped into the tails of the springs, and thrusting against the triangular cock *r*, whilst the others *s s* screw into the cock and bind the springs fast.

Thirdly, the pendulum has the same center of motion as the said two springs, so that when the cross piece of

the pendulum is moving in contact with the pins 9 11, and 8 10, no friction takes place at the parts of contact.

Fourthly, the locking is much more safe than in most of the other remontoir escapements; for here the detent has arrived at its place and is at rest, before the tooth to be locked arrives at it, consequently there is no danger of any tendency to rebound as is the case when two moving bodies come in collision.

Fifthly, the unlocking is easily performed by a direct stroke of the cross piece, made at right angles to the length of the moving pendulum.

Sixthly and lastly, the pallets being constructed without any heel piece or fang, the escape is effected without any impediment or recoil.

The shape of the teeth of the wheels and pinions is as nearly epicycloidal as possible; which I consider an essential requisite to their freedom of action, but which is too much neglected in clock and watch work in general; and the pivot holes of the escape wheel are jewelled.

In order to limit the action of the detent and pallet springs to a certain point, besides their being thinned away at that part of them, holes are made through them also, which determine the point of action.

As I prefer the mercurial pendulum to any other hitherto known for my regulators, I have here given a correct outline of one after the manner I most approve of fitting it up.

Plate XXXVII, fig. 1, is a front view of a mercurial pendulum, having the upper part of the rod removed, as shown by the fracture.

Fig. 2 is a side view of the same: *x x* is the bottom part of the pendulum rod, which is made of steel, and passes through a hole in the upper end of the frame A, which supports the glass that contains the mercury; the rod is well fitted into the hole, so as to have no shake, but

is at liberty to slide through it; on the bottom end of the rod is a screw and micrometer head or nut B, which is divided on the upper side to adjust the length of the rod; C is an index which coincides with the divisions on the micrometer plate; D D are two parallel steel rods, which form the sides of the frame, and are fixed to each side of the head A, which is likewise made of steel; to the bottom ends of the rods is fixed a brass cup E, which receives the bottom end of the glass cylinder E F, in which the mercury is placed; the dotted lines G G represent the inside of the cylinder, the dotted line H H the altitude of the mercury; I is an iron cover or lid, having a brass ring fixed to the under side of it, which receives the upper end of the glass cylinder, and on the upper side of the lid are fixed two pieces J J, with notches to receive the sides of the frame D D, which steadies the upper end of the glass. To the bottom part of the frame E is fixed an index K, which indicates the degrees of vibration on a brass arc, which is divided into degrees, and fixed to the back part of the case of the clock.

These views of the pendulum are drawn to real size.

As the whole length of the pendulum rod is not shown in the drawings, it must be nearly 39⅛ inches from the point of suspension, or vibration, to the center of oscillation to beat seconds in London.

I do not here think it necessary to explain the properties of the mercurial pendulum, as it is already well understood.

I have here subjoined a description of a simple pitching or deepening tool, which I contrived for marking off the proper distance for planting my escapement, and which is applicable to escapements of any other form. I also find it of great service in setting the depth of wheels and pinions, where the pinions are made separate from their arbors.

When I undertook to make the Greenwich clock, I was in hopes of getting a movement all finished and ready for applying my escapement to it; but, on examining the works, I soon found it would not answer my expectations.

The wheels and pinions were all finished by hand, and the usual way of pitching them was, first to set them deep enough, and then to round up a few teeth and make a trial, and if too deep, to reduce the wheel till they ran smooth.

I mention this circumstance in hopes that this practice will be discontinued.

The objection I found the clock-makers had to wheels and pinions finished in the engine, was, the great difficulty of setting them to a proper depth; but by the means about to be described, that objection will be obviated, as a tool of this description is so easily made, that no clock-maker need be without one. For mathematical instrument makers also, this tool will be found of service for setting the depth of their racks and pinions more readily and certainly than by hand.

Plate XXXVIII, fig. 1, represents a front view of the pitching or deepening tool, with my escapement applied to it.

Fig. 2 is a side or edge view of fig. 1; A A is a flat parallel plate of brass, in the center of which a short cylinder or arbor B C is fixed, projecting on both sides and at right angles to the plane of the plate; on the end C of the arbor is fitted the escapement wheel *g*; between the plate A A and the wheel *g* is fitted a parallel plate or collar D of brass, to adjust the height of the wheel to the two spring pallets *m* and *n*; on the other side of the plate A A is fixed a flat bar E E, by the screw F, which screw passes through a parallel slit G G in the bar E E, and screws into the plate A A: the neck

of the screw F is equal in diameter to the end B, which also passes through the slit, and is also equal in diameter to the width of the slit G G; to the upper end of the bar E E is fixed the adjusting plate *q* of the escapement (to which the cock *r*, together with its two spring detents *i* and *j*, and the two spring pallets *m* and *n* are affixed) by means of the screw H, which passes through the slit G G, and screws into the hole 18 in the adjusting plate *q* (see figs. 8 and 9, plate XXXVI). The screw 19 passes through the hole 18 and screws into the back of the frame plate C, and fixes the plate *q* thereto, which has two steady pins I I to prevent its turning on the screw 19 (see plate XXXIV and XXXV).

On the ends of the screw H and the arbor B are made conical centers.

The method of using this instrument for pitching my escapement is as follows:

First make fast the adjusting plate *q*, together with its cock *r* and appendages to the upper end of the bar E E, by the screw H; then place the escapement wheel on the end C of the arbor B C, and slide the end B of the arbor along the groove G G, till the teeth of the wheel are properly adjusted to the two spring detents *i* and *j*, and to the two spring pallets *m* and *n*, that is to say, when the drop of the teeth of the wheel to the detents *i* and *j* are equal; then make fast the plate A A to the bar E E by the screw F; apply then the conical end of the arbor B to the hole in the frame plate C, through which the axis of the escape wheel passes; describe then an arc across a line drawn perpendicular to the center of the escape wheel with the point of the screw H, which will give the distance of the hole in which the screw 19 screws into the frame plate C, and which affixes the adjusting plate *q* with its appendages thereto.

On the lower end of the bar E E is fixed a socket J,

which contains a cylindrical arbor K, on which the pinions are placed when the instrument is made use of for pitching wheels and pinions with holes in their centers. When the pinion is placed on the socket K, and the wheel on the end C of the arbor B C, the end B must be slid along the groove G G, till the teeth of the wheel are properly in contact with those of the pinion; then the conical center of the arbor B must be applied to the hole in which the axis of the wheel is inserted, and an arc described by the center L of the arbor K, which will give the distance between the centers of the axis of the wheel and the axis of the pinion.

The plate A A may be moved along the bar E E, by a screw and micrometer head, so as to adjust the pitch of the wheels to the greatest nicety.

Fig. 3, plate XXXVIII, represents the face or side view of an instrument which I make use of in adjusting the faces of the teeth of the escapement wheel, with a wheel applied to it. Fig. 4 is an edge view of the right-hand side of fig. 3; this instrument consists of a flat plate M M, having a cylindrical stud N fixed in the center, which fits the hole in the center of the wheel, and on which the wheel is placed: on the projecting and back part of the plate M M is fixed a hard steel plate O, by the screw P, the upper part of which projects over the upper edge of the plate M M, and is level with its face; the upper side or face of the piece O is at right angles to the face of the plate M M, and is at liberty to turn on the neck of the screw, when the screw is eased, so as to make the surface coincide with the inclination of the face of the tooth Q of the wheel. Fig. 5 is a side view of the piece O, and fig. 6 is an end view of the same; R is another piece of steel which is fixed on the front side of the plate M M, by the screw S, and has a projecting tooth which acts against the upper side or face of the tooth T of the

wheel, and must be so adjusted that the upper side or face of the tooth Q of the wheel coincides with the face of the steel plate O; then the face of the tooth Q must be filed off level with the face of the plate O, and when finished the wheel must be raised up from the plate till the tooth Q of the wheel can pass over the piece R; then the wheel must be pressed down to the plate M M, and the upper side or face of the tooth Q must be brought and kept in contact with the under side of the tooth R; then the face of the tooth U will coincide with the face of the plate O, and must be filed as before described, and so on till the whole of the teeth of the wheel are completed. Fig. 7 is a side view of the piece R, and fig. 8 a view of the upper edge.

I think it proper to add, for the benefit of the time-piece and regulator makers, that I have enabled Mr. Thomas Leyland, clock-maker, of Prescot, in Lancashire, to cut wheels and pinions with teeth made truly epicycloidal, from patterns generated by myself, and also to make and fit up regulator movements complete.

PAPERS

IN

COLONIES AND TRADE.

N° I.

SCOTCH HERRINGS.

The sum of FIFTY POUNDS *was this Session given to Mr.* J. FRED. DENOVAN, *of Aberdour, in Scotland, for his activity in getting into the Hamburgh Market a cargo of* SCOTCH HERRINGS, *previous to the arrival of the first cargo of Dutch Herrings; and also for the superiority of his Scotch Herrings to those imported by the Dutch fishermen, as proved by the higher price obtained for the former. The following communications have been received from the candidate on the subject.*

Aberdour, Fifeshire,
Feb. 12, 1820.

SIR;

WHEN I had the honour, in October, 1818, of transmitting to the Society a half barrel of herrings for their inspection, I promised, in making my next year's offering to His Royal Highness the Prince Regent (now His Ma-

jesty King George the Fourth), to send to the Society a specimen of the same herrings (of the early species), and which I anticipated, from the arrangements I had made, would be the first herrings taken on the coast of Great Britain. In conformity with that promise I transmitted to my agents at Leith, to be forwarded to the Society, a sixteen gallon barrel of these herrings caught and cured by me, in the Frith of Clyde, on the 14th day of June, 1819; and perceiving from a printed copy of the Regulations sent me in Spring, 1819, that the Society generously offered to extend the same premiums for another year, I have presumed again to become a candidate, and to submit to the consideration of the Society a narrative of my proceedings, to the successful issue of which I proudly and gratefully acknowledge the Society have powerfully contributed.

I am sorry, however, to find, from my correspondent in London, that the specimen of herrings, owing to some accident or mistake, has been much longer in reaching its destination than I expected; and I have also to regret, that just while I was about to sit down to address you, I was subpœnaed to give evidence in a civil trial, by jury, in the West of Scotland, regarding the loss of a vessel, which has detained me until now; I can therefore only submit myself to the indulgence of the Society for the delay that has unavoidably taken place.

In my former letter I fully explained to the Society that the object of my undertaking was to obtain a preference for the British white herring fishery on the continent of Europe, by endeavouring to anticipate the Dutch, by importing into Hamburgh an article equal in every respect, if not superior, to what they had been in the habit of vending in Germany for at least two centuries past; and having at the same time given, by affidavit, a full description of the process employed, I feel it unnecessary to swell

the present communication by a repetition of what is already in the possession of the Society; but every deviation from, or improvement on, the original process shall be distinctly explained.

Early in June 1819 I freighted the sloop Mary Ann, of Glasgow, John Macfarlane master; and having provided her with the necessary stores, proceeded to the Frith of Clyde, where, after shifting about from bay to bay, and head to head, I fell in with the first small shoal of herrings, on the morning of the 14th of that month, off Tarbet; and having made signals to the fishermen, had about three barrels on board in the course of the day. Of these I packed up the half barrel for the Society, and the quarter barrel for the Prince. From the pains I had taken during the three years preceding in instructing both the fishermen and their sons, in this neighbourhood, in the Dutch mode of gutting, assorting, laying, packing, re-packing, and pickling the herrings, I conceived I might safely try the experiment without having resource to foreign aid, and the result has fully justified my expectations. To satisfy the Society on this point, I have the honour to produce a certificate from Messrs. M. and A. Mac Laren, fish curers in Glasgow, the proprietors of the Mary Ann, and from whom I freighted her, proving that this was the case; and also certifying the quantity of herrings cured by me on board the vessel for exportation to Hamburgh. Having, on the 24th of the same month, taken altogether about fourteen barrels, sea stock, which were re-packed into eleven whole barrels for exportation, exclusive of the half and quarter barrel and a few kegs for home consumption, I proeeeded to Glasgow, which I reached on the 26th, and forwarded my herrings to Leith, where they were shipped on board the smack Courier, John Henry master, for Hamburgh. After landing my herrings at Glasgow, I returned again to the Frith of

Clyde, and having taken, cured, and repacked for exportation thirty-five and an half barrels more, I came back to Glasgow on the 10th of July following, pushed on to Leith with what I had taken, and shipped 34 barrels to Hamburgh, by the smack Glasgow, Walter Paton master, retaining one barrel and a half for the supply of my friends at Edinburgh, in kegs.

It is singular, although the finest herrings in the world are to be had in abundance on the coast of Scotland, that the natives had never been stimulated to profit by the advantages they possess, while this very herring fishery became, as it were, an inexhaustible source of wealth to a foreign nation, who, to use their own words, founded their metropolis on herring bones! but that the subjects of Great Britain should have tamely and supinely submitted to the disgrace of seeing a foreign nation take away these very herrings from their doors, to supply a foreign market which it was their birth-right to have filled; without once reflecting that the Dutch had to fit out large deep sea vessels, at a very great expense, to accomplish an object which a poor Scotch fisherman might have effected with his little boat; and that every barrel of herrings drawn from the sea was so much real wealth acquired by the nation.—Remarkable as this may appear, it is nevertheless a fact which will not admit of contradiction; and that for upwards of two centuries past, the Dutch have not only imported (if I may be allowed the expression) the first Scotch herrings to Hamburgh, but have found means to maintain such a preference in the German market, that British herrings, although caught in the same water, never brought above *one-third* of the price at which Dutch herrings were sold; while, in consequence of the small profit earned by the exporter, QUANTITY and *not quality* was considered an object; and if the curer, from the extent of his capital, could afford to

send over 3 or 4,000 barrels, he was remunerated for his trouble, by receiving the 4*s.* per barrel of bounty paid by government, if he got no more; and contented himself with endeavouring to *undersell* the Dutch by glutting the market with an inferior article. Yet to imitate the Dutch, in their mode of cure, was even with these very men *considered to be nonsense;*—they held up their herrings to be as well cured as the Dutch; while the idea of anticipating the Hollanders in the German market was not only thought ridiculous, owing to their using busses, but even in June last, when I set out on the fishing, I was told by two of the first-rate curers in the West of Scotland, and who have *amassed fortunes by curing quantities,* that the thing was impossible; and that no herrings were to be found in our bays, *in condition for curing,* until the months of July or August.

I am proud however to say that my favourite scheme has at length opened the eyes of my countrymen, and that my humble endeavours have at length been crowned with success. My first shipment of eleven barrels reached Hamburgh on the 4th, and they were exposed to sale on the 5th of July, before the Dutch with a fleet of 269 deep sea busses had brought a herring to that market. It is customary in Hamburgh, as in Holland, to ring the bells in the steeples on arrival of the *first* or *new* herrings; but this was the only occasion on which the bells of that city had ever proclaimed the arrival of *British new herrings,* which were sold at the enormous price of *fifty dollars per barrel!*

Some gentlemen, I believe, from London, who were desirous of making a similar attempt, contracted with the curers in the neighbourhood of Lochfine, to cure for them a quantity of herrings for the Hamburgh market on my plan, but these curers, bigotted as it were to their own system, induced these gentlemen to believe that their

mode of cure was equally good, and prevailed on them, to send out the herrings in that way, in the hope of obtaining as high a price; but the certificate (which I have now the honour of producing) under the hand of the *first* fishmonger in Hamburgh, and certified by the British Consul, will prove that both these fish-curers and their employers were widely mistaken in their ideas; and one of the former has since called on me, and not only expressed a conviction of his error, but has made overtures to me to cure in conjunction with him next year, when he will be guided by my advice.

A great commercial house at Hamburgh having the preceding year purchased a part of my herrings in that city, and calculating on the probable success of such an undertaking, and of the profit that might be expected to result from an importation of herrings cured in the same way, sent over to Scotland a number of German herring packers, who being assisted by a British curer in the Frith of Clyde, cured and sent to Hamburgh a considerable parcel of herrings; but owing to the injudicious manner in which the fish were gutted and packed, and the bad quality of the salt, a few barrels only sold at 60 merks, while the remainder were disposed of nearly at cost price.

After both these parcels had been sold, and after three cargoes of Dutch herrings had come to market, my second shipment, consisting of 34 barrels, reached Hamburgh. It must be allowed that they came then at a disadvantage, and had nothing but their quality to recommend them; yet, as is proved by the certificate before mentioned, they sold at from 90 to 120 *merks per barrel,* which clearly established their superiority in point of cure, to the shipments which had been previously made both by the Dutch and by those who had become my opponents.

Although it is highly gratifying to my feelings to re-

flect on the success I have had, and that I am the *only British subject* who has conquered the Dutch at their own weapons, in a branch of trade peculiarly our own, and which may be productive of great national advantage; yet it becomes a duty on my part to acknowledge with gratitude the protection and support I have experienced from the liberality and discernment of the Society. It would pain me to think, that I offered only flattery where sincerity was due: no doubt many compliments are in this way paid to the Society by individuals like myself, who have experienced their bounty; but they should not be despised—to return thanks to his benefactor is but too often all that a poor man can do; and I hope, in doing as others do, it may be believed that my offering is at least genuine.

When I first addressed the Society I candidly explained to them the difficulties I had to combat, and the loss I had sustained by the failure of a Hamburgh house to whom my herrings were consigned. When I embarked on my undertaking in May last, my finances were extremely slender, so much so that I hardly knew how to manage; and therefore the Fifty Guineas voted me by the Society operated not only as a stimulus to exertion, but as a most seasonable assistance in promoting the success of my undertaking. While thus I acknowledge with gratitude the liberality of the Society, I flatter myself they will not disdain to participate in the triumph of an individual who owes, in a great degree, his success to their bounty.

Most men are anxious to conceal their poverty; but situated as I am, I feel proud in avowing it. It has been generally believed that a poor man had no chance of enriching himself by the white herring fishery; and that, for the reasons before stated, men only of capital could embark in it with success; but I flatter myself I have not

only exposed the fallacy of an opinion, which has been productive of the most pernicious effects, but demonstrated to the country at large, that every poor man may enrich himself by the fishery, if he will only be industrious and persevering. He must not, however, as too many have done, *depend on quantity*, and *on the* 4*s. bounty* to be received from government. He must be attentive as to *quality* and *cure* for his remuneration; and, instead of leaning on government for support, he must, as I have done, seek for bounty in the markets of a foreign nation.

Having received immediate remittances for my two shipments from Hamburgh, I left the Frith of Clyde, and proceeded to Dunbar, where herrings were got in great plenty, and at a much lower price. I cured, *with British subjects, openly and publicly, on shore, so as every one might learn and profit by my example, one hundred and forty barrels,* of excellent herrings, which were shipped for Hamburgh, by the smack Albion, Parker, master. These herrings, although the Hamburgh market was then very full of inferior British fish, would, I am convinced, have left a very handsome profit; but the vessel was unfortunately stranded on the island of Ameland, on the Dutch coast, and I was disappointed in my hopes of gain: having, however, effected insurance on the parcel, and recovered from the underwriters, I have suffered nothing by the disaster.

In proof of these facts, I have the honour to lay before the Society a Certificate from Messrs. Kelly and Sawers, most extensive and respectable fish curers at Dunbar: men who were formerly bigotted to their own system, but from having paid great attention to my movements, while at Dunbar, have publicly expressed their desire to imitate my example in future; and the Certificate

now produced, distinctly explains their opinion as to the superiority of the plan adopted by me.

I have also the honour of laying before the Society a letter from the right honourable Sir Benjamin Bloomfield, bart., written by desire of his then royal highness the Prince Regent (now his Majesty, King George the Fourth), acknowledging receipt of the quarter barrel of herrings; and I am assured from high authority, that my herrings have not only become of use, but are a standing dish at the royal table.

I could have forwarded to the Society a much finer specimen of herrings than those contained in the half barrel, had I waited until the season was further advanced, and the herrings had become more full, and attained a greater size; but I promised that the Society should have a fair specimen of the *first fruits* of my labour, and I have kept my promise. It is a very easy matter, in the middle of the season, to put up a barrel, or half a barrel, of superior herrings; but I have the honour of laying before the Society *a fair specimen* of herrings *actually caught and cured on the* 14*th of June*, nearly a month before the British curers commence their operations, and *ten days* before the Dutch statute permits a subject of that country to cast a herring net in the sea, on the foolish and superstitious notion that herrings are not in a condition to be cured before the Eve of St. John. I pledge my honour that the herrings now sent, are a fair specimen of those forwarded to the Prince Regent; and of those shipped to Hamburgh, for which the price of fifty dollars per barrel was paid; and I flatter myself that no such specimen, of *early herrings* can be produced by any Dutch or British curer whatsoever; and I pride myself the more in this, from the fact which will be admitted by every man conversant with the curing of herrings, that owing to the great quantity of fixed oil

they contain, more care and attention is required in curing *one* barrel of early herrings, than *twenty* of the later species, which are taken in September and October. And I further pledge my honour, that the whole of the herrings cured by me last season, were done in the same manner as those in the half barrel, without any difference in the process, saving and except the diminishing or increasing the quantity of salt, as the fatness or leanness of the fish required it.

Having often observed the strong antiseptic powers of moss water, on vegetable and animal substances, I conceived that it might be used with effect in the cure of herrings, particularly of those intended for a warmer climate, and I resolved to try the experiment on a small scale: I first cured a few kegs of the later herrings (in October 1818) in the usual way; but, instead of throwing away the gut, gills, and bloody part, as is customary, I put them into a small cask, with a proportionate quantity of Lisbon salt, and pressing down the whole by means of an iron plate, a dissolution of the salt took place in a few hours, and a strong red pickle was produced, on the top of which the fixed oil was floating. After carefully skimming off the oil, I added one third of strong *brown* moss water, taken from a natural pond formed in the Moor near Eyemouth; and having taken the herrings out of the original pickle, I packed them anew, and filled up the kegs with this pickle. On opening them some months afterwards, I not only found they were in excellent preservation, but that the scales (which always proves the quality of the pickle) were as bright as when the fish were taken out of the water. I presented one of these kegs to my respected patron, the Earl Morton, who has generously given me some premises at this village, *rent free*, to facilitate the progress of my undertaking. I also sent a keg to Sir John Sinclair, bart. who had had

several conversations with me on the subject of the fishery; and the third I kept until the latter end of May 1819, when the weather was very hot: on opening it, I found the fish *in* PERFECT *preservation*; and I sent it to the right honourable the Lord President of the Court of Session: his lordship is reckoned a connoisseur in herrings, and was not only consulted by the late Mr. Rose, in framing the Deep Sea Fishery Bill, but was president of the Fishery Board for many years. I have the honour of producing returns from Earl Morton and the Lord President, expressing their opinion of the quality; as also, a letter from Sir John Sinclair, animadverting on the species of the herrings, as being full of milt and roe, in which he is perfectly correct (for as I have observed they were taken in the latter part of the season) and expressing a hope that I should be able to cure a superior article *early* next season, alluding to *early herrings*, such as I have now had the honour of sending to the Society. Sir John also adverts to the use of moss water, not only in the cure of herrings, but also in preserving meat and butter, and believes it might be greatly strengthened by evaporation. I have since had different conversations with Sir John on this topic, and intend this season to give the thing a fair trial; for during the last summer it was not in my power to make arrangements for this purpose. When I have brought the matter by repeated experiments to some kind of maturity, I shall have the honour of communicating the result to the Society.

Although various schemes have been tried to preserve herrings in the warm climates, they have never, as far as I can learn, been attended with success; and although the pickle prepared with moss water may be extremely serviceable in shipments made to the Colonies, still I am of opinion that a different treatment of the fish will be necessary to bring about this desirable object: if the

operation of gutting had the effect (as is erroneously believed) of opening the whole blood vessels of the body and head of the herring, a strong antiseptic pickle, judiciously used, would undoubtedly carry the herrings to any climate in the world; but in dissecting the herring, it will be found not only that the head contains several smaller vessels, but that a LARGE *blood vessel* from head to tail of the fish lies behind the back-bone, with which the gutting-knife never comes in contact, and which of course are not discharged during that operation. This large blood vessel, as may reasonably be conceived, soon yields to the heat of the weather, and blackens the bone; and the spine and brain being next affected, the whole fish becomes immediately rancid and unwholesome.

If the herrings, however, when gutted were laid on a board, by dozens, and THE HEADS CHOPPED OFF *with a large knife*, and cured in the manner I have stated, with moss water, I am confident they might be conveyed to the East or West Indies, in as high perfection as to Hamburgh; and if our colonists would only reconcile themselves to the idea of eating herrings *without heads*, they might enjoy them in as great style as a burgomaster of Amsterdam.

These my humble efforts to improve the cure of, and to obtain a preference for British herrings, I submit with deference to the consideration of the Society; and grateful for the liberality I have already experienced, fondly hope they may be honoured with their approbation. I have the honour to be, with much respect,

Sir,

A. Aikin, Esq. &c. &c. &c.

Secretary, &c. &c. J. FRED. DENOVAN.

CERTIFICATES.

Hamburgh,
December 15, 1819.

THESE are certifying all whom it may concern, that Mr. J. F. Denovan, of Aberdour, in Scotland, imported to this city, on the 5th of July last, by the smack Courier, of Leith, Thomas Henry master, eleven barrels of early Lochfine herrings, cured in the Dutch manner; which herrings arrived in this port previous to the jagers of the Dutch Deep Sea Fleet, and averaged the price of fifty dollars, Hambro' currency, per barrel: and it is further certified, that no British subject has ever before outsailed the Dutch, or made such an early importation; neither has such a high price been before obtained for British herrings.

That shortly after Mr. Denovan's parcel was sold, several importations of Lochfine herrings were made to this port, and were sold on an average at 32 and 34 marks per barrel; while a second importation of Mr. Denovan's, on the 23rd of July, by the smack Glasgow, W. Paton master, of thirty-four barrels of Lochfine herrings, cured by him, were sold from 90 to 120 merks per barrel; and the superiority of Mr. Denovan's method of curing was proved more distinctly this season, when compared to an importation of about 70 barrels, cured likewise by Dutchmen, which did reach our market about the same period, out of which only 20 barrels fetched from 48 to 60 merks, the remainder from 32 to 36 merks per barrel; and there is little doubt, if Mr. Denovan is enabled to persevere, that his plan must ultimately have the effect of enhancing the price and conducing to the establishment of an extensive market for the sale of British herrings on the continent; by which means the Dutch herring trade might be successfully opposed, provided Mr. Denovan is sup-

ported in his undertaking by legal permits to *supply himself with the proper materials, the ensuing season, on a larger scale.*

J. Louis Bertheau,
for Jurgen Bona Meyer,
Fish Curers.

Hamburgh,
December 16, 1819.

These are to certify that this day personally appeared before me, at the British Consulate General in this city, Mr. J. Louis Bertheau, having the full power of Messrs. Jurgen Bona Meyer, fish curers of this city, and made the above declaration, and that the above signature is his proper hand-writing.

J. C. Mellish, *His Majesty's Consul General.*

Hamburgh,
May 13, 1820.

I, the undersigned Jurgen Bona Meyer, fishmonger in Hamburgh, complying with the application made to me to give some further information concerning Mr. J. F. Denovan's importation of early herrings, consigned to me last season, do certify and attest that 11 barrels shipped per the Courier, Thomas Henry master, arrived on the 5th of July, before the Dutch jagers from the Deep Sea Fleet had made their appearance: five of these barrels were sold the same day to the inland dealers at sixty dollars currency, and the remainder went off readily in small parcels by retail, and also in small kegs to the inland carriers, the contents of the whole lot amounting to 1,142 mark banco.

That the barrels in which these herrings were contained were of common size; they were, however, of oak, and

hooped in the Dutch manner. Dutch and British herring barrels are nearly of the same dimension, but the Dutch are made of well-seasoned oak, while those of the British are made from different woods, and some of them from fir, which not only injures the fish, but generally absorbs the pickle.

Mr. Denovan's second importation of 34 barrels of Lochfine herrings per the Glasgow, Walter Paton master, were received on the 23rd of July: this shipment, however, had materially suffered from the voyage; several barrels had staves broken in, which rendered the contents of 6 barrels unmerchantable, and a similar accident had also happened to one barrel of the first importation: ten barrels were sold to the inland dealers at forty and thirty dollars currency, and the remainder was partly sold by public sales at 85 marks, and partly retailed in small kegs to the inland carriers, making the contents of the whole shipment amount to 2,214 mark banco.

On the 12th of July the Dutch jagers reached port, and up to the 1st of August were paid with fifty dollars currency per barrel, although they were not first quality; but this is not to be wondered at, considering the connexion and interest which the Dutch have in this port, and the deep-rooted prejudice entertained by the consumers against herrings imported from Great Britain. The first Prussian jager of a very fine fish fetched only seventy mark currency per barrel; and on the 14th of July early Lochfine herrings were brought to public roup by a Scotch gentleman, and only a single barrel went off at 53 marks: the sale was withdrawn without leading to a more seasonable result. While such is the nature and the situation of the British trade upon our market, Mr. Denovan's bold and well-managed attempt has, however, had the effect to open the eyes of many: should he persevere steadily, and should his example be followed by his coun-

trymen with *due circumspection*, there is little doubt but a new mine of wealth will be opened to the industry of the British nation, and he and his countrymen are heartily welcome to my best exertions for their interest.

I embrace this opportunity to refer every one, interested to support Mr. Denovan's well-concerted projects, unto Mr. Bertheau, whom, by his experience and knowledge I deem most competent to afford effective assistance towards the attainment of the object the Honourable Board of Fishery contemplated, when it recommended the adoption of the Dutch method of curing, the expediency as well as the importance of which, proves to be most satisfactorily substantiated by Mr. Denovan's patriotic endeavours.

JURGEN BONA MEYER.

These are to certify that the signature Jurgen Bona Meyer, on the other side, is the proper hand-writing of Mr. Jurgen Bona Meyer, a citizen and fishmonger of this city. Witness my Hand and Seal of Office.

In the absence of the Consul General,

CHAS. WESSELHOEFT, *His Majesty's Vice Consul.*

Dunbar,
January 20, 1820.

THESE are certifying all whom it may concern, that, in the month of September last one hundred and forty barrels of white herrings were cured in our premises here, in the Dutch manner, under the direction of Mr. J. F. Denovan, of Aberdour, in Fifeshire, and that no Dutch fishermen were employed, either in taking, gutting, or packing the same; but that the whole operation was performed by natives of this place, under the orders and

superintendence of Mr. Denovan, and a friend who attended in his absence.

As professional men, we give it as our opinion, that Mr. Denovan's plan is very far superior to the general usage of this country. The scales are preserved more entire, the fish retains its fine natural shape and juices, and the flavour is entirely different; and there can be little doubt, were his system adopted at the different fishing stations, that great advantages would be reaped by this country, in exporting herrings to the continent of Europe.

The herrings alluded to were intended for the German market, and were shipt on board the smack Albion, Parker master, for Hambro'; but the vessel was unfortunately stranded on the Dutch coast and the cargo abandoned to the underwriters. Although the German market was very much depressed by extensive exports from this country, still we are assured that had these herrings reached their destination, they would have brought a much higher price than those cured in the common way, with which Hambro' was then glutted.

KELLY & SAWERS, *Fish Curers.*

SUPPLEMENT.

ON reference to Vol. XXVIII of the Transactions of the Society, page 179, will be found the description of an Improved Mathematical Dividing Engine, invented by Mr. James Allan, of Blewett's Buildings, Fetter Lane, London. The Society considered the improvements introduced into the engine by Mr. Allan, as deserving their Gold Medal, the highest reward which (according to the rules of the Society) can be conferred on one of their own members.

As a confirmation of the judgment passed by the Society, and as a testimony alike honourable to the skill of the Artist and to the liberality of the Board of Longitude, the Society willingly give a place in their volume to the following letter from Dr. Young, transmitted to them by Mr. Allan.

Admiralty,
February 3rd, 1820.

SIR;

I HAVE the pleasure to inform you that the Board of Longitude has this day been pleased to grant you the sum of one hundred pounds, as a reward for your ingenuity, displayed in the improvement of the dividing engine.

I am, Sir.

&c. &c. &c.

Mr. Allan. THOMAS YOUNG, *Sec.* B. LONG.

VOL. XXXIV.

THE references to Mr. W. Bremner's Instrument for the Extirpation of Polypi, plate 18, and to Mr. Jon.

Dickson's Method of Propelling Steam Boats, plates 28 and 29, are omitted in the first edition of this volume, but have been inserted in the second edition of the same. In order that those who are in possession of the first edition may have the above noticed omissions as far as possible supplied, it has been thought proper to insert here the following descriptions:

Reference to the Engraving of Mr. W. Bremner's *Instrument for the Extirpation of Polypi,* Plate XVIII.

Fig. 7, the cannula and screw complete, with the doubled cord *x* passing through it. Fig. 9, the notch pointed probe. Fig. 8, the screw detached from the cannula; *s s* are two feathers at the end of the screw, which slide in the grooves *r r* in the cannula, sections of which are shown in fig. 10: *v*, fig. 7, the groove in the screw head to secure the ends of the cord *x*; *t*, figs. 7, 8, the nut, having a milled head, which being turned, causes the screw to advance or recede within the cannula; *w*, a screw the end of which works in the groove *u* of the nut and retains it in its place; *v v* a plan of the grooved screw-head.

Reference to the Engraving of Mr. Jon. Dickson's *Method of propelling Steam Vessels,* Plates XXVIII and XXIX.

1 1, a section of the vessel; 2 2, the float-wheels impelled by an engine acting on their shafts A B, having on each a toothed wheel, which acts on other toothed wheels fixed on the axis of the float-wheels. Each float-wheel is hung on a pair of levers 3 3, turning on the center C, coincident with the axes of the first-mentioned toothed wheels, so that although the levers are elevated at one end, and

with them the float-wheels, yet the relative distances of the two toothed wheels are preserved, the one having what is called a planetary motion round the other. The left-hand float-wheel, (plate XXVIII), is shown dipping in the water, while that on the right hand is lifted out of it by the action of the winch E communicating motion, through two small wheels and two pinions, to the barrel 4 4, coiling round chains attached to the ends of the levers 3 3. The left-hand figure in plate XXIX, is a bird's-eye view, and the right-hand figure is an elevation showing distinctly the action of the levers 3 3, and their connexion with the toothed wheels. The dotted lines exhibit the positions of the wheels and levers when raised to their greatest height.

VOL. XXXVII.

The Society having last Session rewarded Mr. Russell for the application of Mr. Bramah's Lock to the purpose of locking liquor cocks, and it appearing that the description of the lock so applied, is not so complete as might be desired, the following additional explanation is published:

Very full and explicit engravings of the lock and its application are given in Vol. XXXVII, of the Society's Transactions, plates XI and XII, to which the reader is referred.

Figs. 2 and 3, plate XI, exhibit the external appearance of the cock so protected, in one case by the lock being affixed to the side, and in the other to the front of the barrel.

The manner in which the bolt *c*, figs. 1 and 2, plate XII, is advanced into, and withdrawn from the plug of the cock by the revolution of the barrel of the lock and the screw *b*, has been shown in the description accompanying the plates; as also has the nature of the slits in the key by references to figs. 20, 21, 22, and *d*, fig. 1, the two former

20 and 21, being merely diagrams for the purpose of elucidating the principle of its action. It is now, therefore, only requisite to give a fuller exposition of those parts of the lock on which its peculiar security depends.

Figs. 1 and 2, plate XII, are full sized sections of the lock; these are evidently too minute and complex to admit letters of reference to the individual parts, which must consequently be described by their detached representations; and their relative situations in the sections may be discovered by an attentive examination of their several forms and uses.

Fig. 6 is a section, and fig. 7, an end view of what is designated the revolving barrel; in fig. 6 are seen the screw holes by which the circular plate attached to the screw *b*, fig. 15, is secured to it. The deep groove which is cut in the periphery of this barrel is occupied by two semicircular plates of the form fig. 11, and shown in an edge view fig. 12, making together the circle fig. 10, and this is called the locking plate; it is prevented from revolving with the barrel by means of the broad hoop, figs. 16, 17, the two projections from the end of which enter into the notches formed in the external circumference of the semicircular plates, fig. 11; the latter, therefore, cannot revolve without the broad hoop, which is prevented from so doing by being screwed at *h h*, fig. 1, to the outer case of the lock. The cylindrical stud which stands on the inner surface of the hoop, fig. 17, forms a stop to a small pin affixed to the circular plate, fig. 15, and limits the motion which can be given to the barrel, to rather less than one whole revolution; the stud and pin are both shown in the section, fig. 2, immediately on the right hand of the bolt *c*, the stud below, and the pin above that part of the screw which is visible. The dotted line in fig. 16, describes the relative situation of the locking plate when applied to the hoop, which is secured, as before

stated, to the outer case of the lock; *a a* is the outer case in figs. 1 and 2, and it is shown separately in fig. 8, where the place of the hoop and locking plate is ascertained by dotted lines.

There are four (or any arbitrary number of) longitudinal grooves inside the barrel, two of which are seen in section, fig. 6, and the ends of all of them in fig. 7; these grooves, which approach in depth as near to the external circumference of the barrel as its requisite strength will permit, are continued through the locking plate, fig. 10: the peculiar indented form which they assume in the latter, will be hereafter accounted for.

Now, it will be easily understood that, inasmuch as the locking plate is fixed, if the longitudinal grooves in the barrel, and continued through that plate, are filled with slips of metal, the barrel will be immoveable. These grooves, therefore, are thus occupied by pieces called sliders, of the form, figs. 13 and 14, having a sort of hook or projection which advances to meet the center pin of the lock, in order to receive the action of the key, and against the underside of which, the plate *g*, fig. 15, presses, impelled by the spring *f*; the motion of the piece *g* is limited by the shoulder within the barrel, fig. 6, and when in this situation, the ends of all the sliders are in the same plane.

In order, however, that the sliders, figs. 13 and 14, may permit the revolving of the barrel when depressed to their respective stations by the key, one notch is cut in the outer edge of each, equal in depth to the distance which the locking plate projects into the longitudinal grooves, equal in width to the thickness of the locking plate, and at such irregular distances from the extremities, that the similarly irregular slits in the key may bring them all into the plane of the locking plate, which will then evidently not interfere with the motion of the barrel, because so

much of the inner circumference of the locking plate as before opposed the motion of the sliders, and consequently of the barrel, will now be traversed by the notches just described. The small bit which projects from the key (*d*, fig. 1 and fig. 22) is received into an opening in the smaller part of the revolving barrel, fig. 7, and at the same time that it turns the barrel, limits the depth to which the key can be introduced into the lock; on its being withdrawn, the spring *f*, fig. 15, raises the sliders to their original level. Figs. 3, 4, and 5, are a side and two end views of the revolving barrel with the bolt, screw, spring, sliders, &c. in their places.

It will have been observed that there are two notches in the back of each slider yet unalluded to; their addition is one of the latest and most effectual improvements made to Mr. Bramah's lock in protecting it from surreptitious attempts. Their use can only be understood from a minute description of the methods employed in picking locks, which it is unnecessary to give here; suffice it to say, that by considerable skill and perseverance, and by taking advantage of the unavoidable inaccuracies of workmanship in articles of this description, it was possible in many cases to discover the requisite situation for the sliders to allow the turning of the barrel. It is, however, only right to state that all locks having tumblers or sliders, were exposed to the same defect, almost all admitted, and to many have since been applied a similar sort of remedy.

By the addition of these false notches (as they are called), which are not so deep as the true ones, and by widening the inner portion of the grooves in the locking plate, fig. 10, which allows a trifling degree of motion in the barrel, when the false notches are brought in the plane of the locking plate, it is totally impossible that the violator should know whether it is the true or one of the false notches which he has brought to the locking plate,

the latter in fact are more easily so placed, and if there is but one in that situation the lock is still secure. Thus, by increasing the number of sliders and false notches, the difficulties of picking multiply in a rapidly increasing geometrical ratio to an almost infinite extent. It may perhaps render the subject a little more intelligible, to state that the circumstance from which arises the very great additional security obtained by the introduction of so simple and costless a contrivance as the false notches, is the impossibility of giving a simultaneous and just sufficient motion to the sliders of this, or the tumblers of any other lock, by any instrument short of a fac-simile of the key; the consequence is, that no small degree of dexterity is used in hanging (as it is technically termed) the tumblers or sliders one at a time on the edge of the locking plate, or on that which answers the same purpose in other locks; from this it will be perceived how fatal an obstacle the false notches are, which, as has been before stated, cannot in this operation be distinguished from the true ones.

Fig. 18 is a section across the barrel and sliders at the locking plate, the sliders being depressed to their proper depths by the key, and together with the barrel being in the act of turning round.

Fig. 19 is also a section in the same plane, showing the sliders with their false notches brought to the locking plate, the peculiar form of the grooves of which permits, as before mentioned, a very small motion in the barrel, but not enough to influence the bolt of the lock.

The edge view of the sliders in fig. 14, now only remains to be explained; it is obvious as all the sliders are acted on by one spring, that when one is depressed more than the rest (which is the case every time the key is introduced), all except that one are deprived of the support of the spring, and would when the lock was situated vertically, drop as far as the spring receded; to

prevent which, they are constructed of two thicknesses of metal, a little opened at one end, forming of themselves a spring, the friction of which against the sides of the grooves retains them at any height unsupported by the spiral spring. This effect is illustrated in fig. 2, where the lower slider only, being that which is received into the shallowest slit in the key, is opposed to the spring, the upper one remaining at a distance from it, equal to the difference between the depths of the two slits.

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Tiles made of Parker's Cement, in imitation of Ancient Greek Tiles.

Specimens of Christiana Glass.

CHARLES WILLICH.

A Lithographic Map of the River Thames, from London to Margate.

WM. WYON.

An Impression of the New Medal of the Society, executed by him.

A CATALOGUE

OF THE

MODELS, MACHINES, &c.

Received since the Publication of the Thirty-seventh Volume of the Society's Transactions.

In Chemistry and Mineralogy.

SPECIMENS of Chromate of Iron, discovered in Shetland, from Dr. Hibbert.

A Hydrometer, from Mr. Stokes. See page 27.

A Marine Thermometer Case, from Mr. R. Jamieson. See page 32.

Specimens of Glaze for Porcelain, from Mr. J. Rose. See page 42.

In Polite Arts.

A Parallel Rule, from Mr. A. Harrison. See page 45.

In Mechanics.

Mr. Austen's Improvement in Corn Mills. See page 65.

Mr. R. Pering's improved Mud Boat. See page 117.

Mr. F. C. Cherry's improved Springs and Blocks for Carts. See page 93.

Mr. J. Smith's improved Umbrella. See page 72.

Mr. J. White's Double Door Spring. See page 70.

Mr. J. Perkins's improved Ships' Pump. See page 106.

———————— Improvement in the Construction of Water Wheels. See page 109.

———————— Improvements in Hose for Fire Engines. See page 102.

Captain G. F. Stack's Apparatus for the use of those who have lost an Arm. See page 121.

Mr. W. Hookey's Improvements in Naval Architecture. See page 125.

Captain James Burton's Method of propelling Ships of War. See page 136.

Mr. J. Gorman's Spring Bandage. See page 76.

Mr. J. Prior's Striking Part of a Clock. See page 59.

Messrs. Jeffries' and Halley's Blowing Machine. See page 87.

Mr. A. Ainger's Spring Latch. See page 111.

Mr. O. Elliott's Safe Coach. See page 143.

Mr. G. Davies's Sun-Dial. See page 147.

Mr. Joseph Jopling's improved Construction of the Ribs of Groined Arches. See page 83.

Mr. R. King's improved Method of making Anvils. See page 78.

Mr. W. Bullock's Ball Valve for Cisterns. See page 57.

Mr. J. Skinner's Machine for Sweeping Chimnies. See page 73.

Mr. H. C. Jennings's Mercurial Log Glass. See page 115.

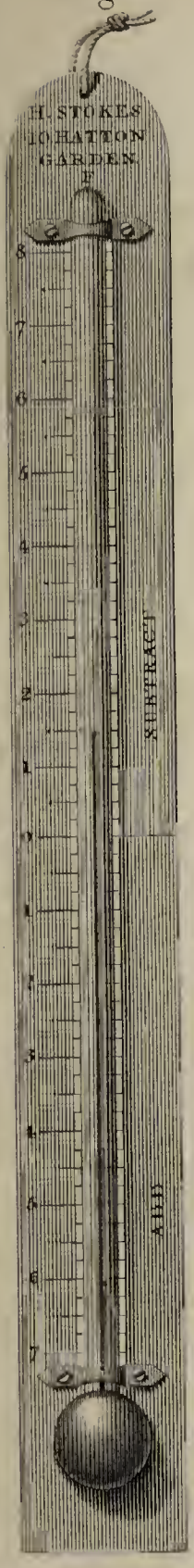
Mr. A. H. Holdsworth's improved Method of constructing Roofs. See page 62.

Mr. W. Hardy's Detached Clock Escapement. See page 165.

Mr. H. Trengrouse's Apparatus for Saving Lives in case of Shipwreck. See page 161.

A LIST

Fig. 2.



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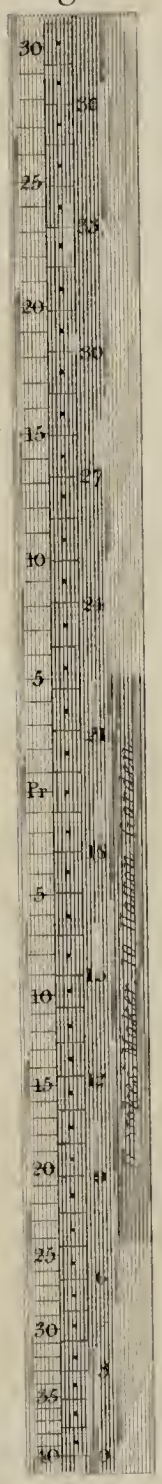
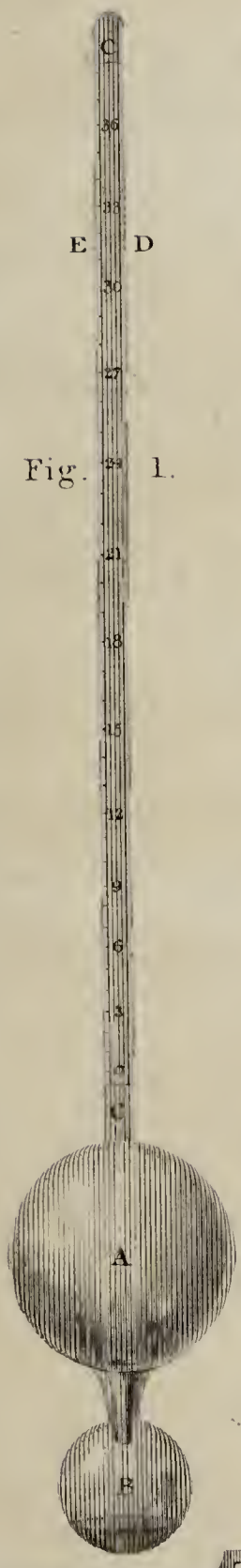

Mr. H. Stokes's Hydrometer.

Fig. 1.



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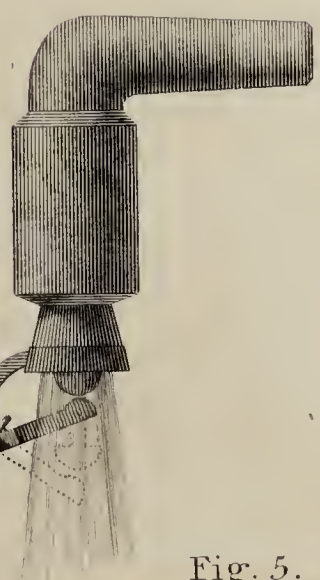

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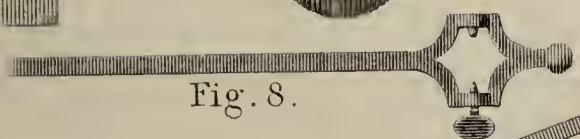


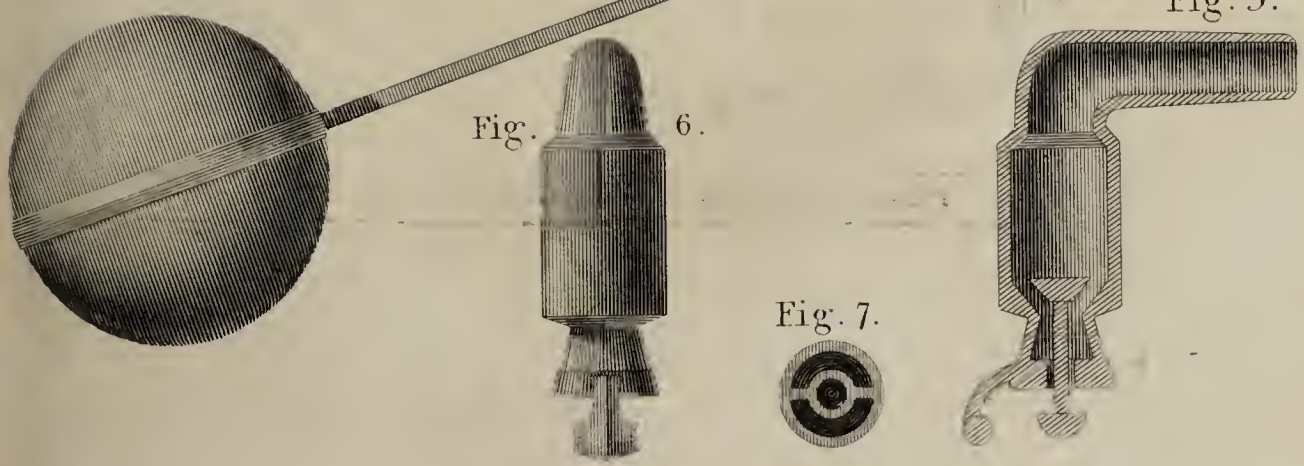


Fig. 5.

Fig. 6.

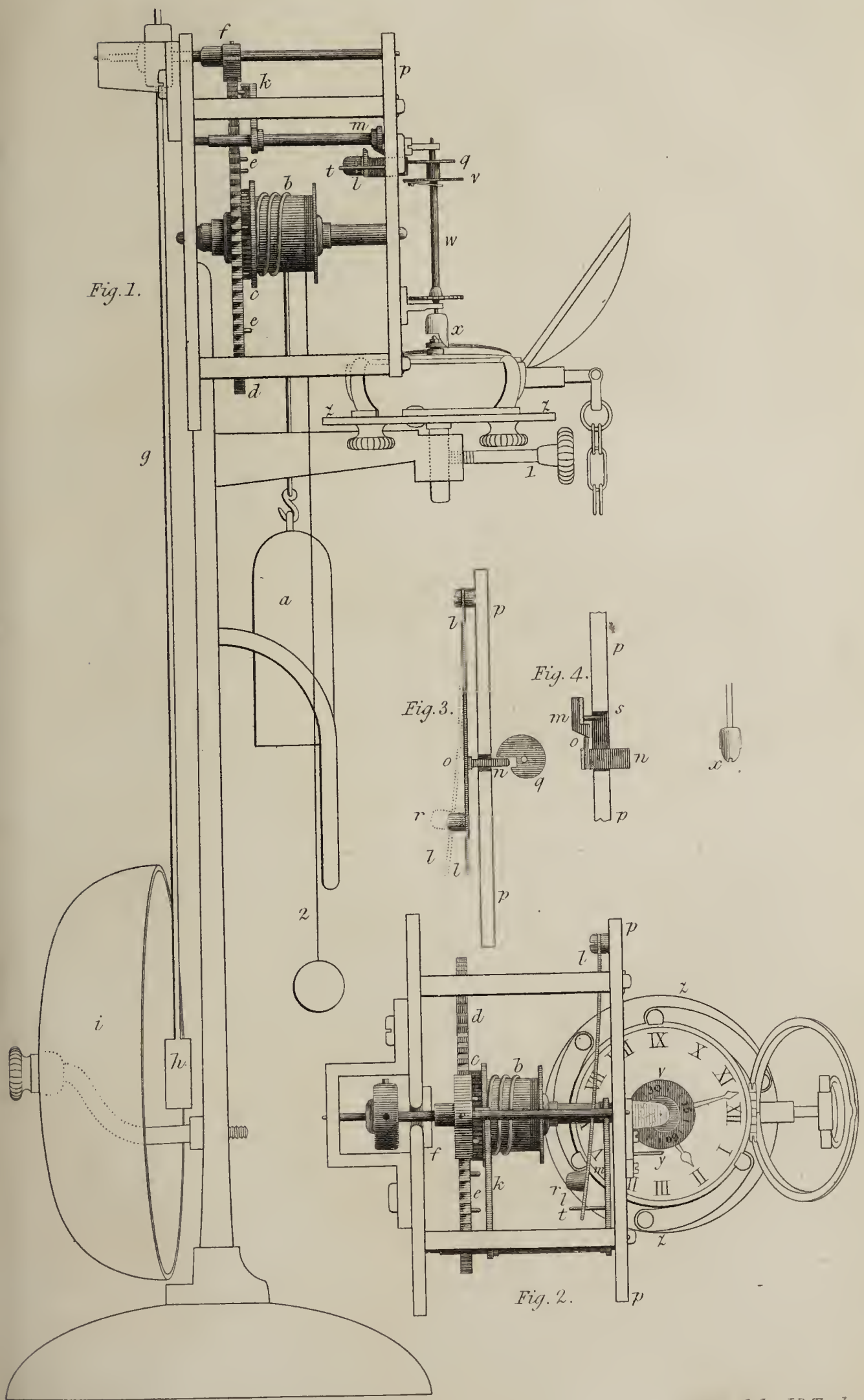
Fig. 7.

Mr. Wm. Bullock's Bell Valve.

Drawn by R. Cocking.

Engraved by W. Helsall.

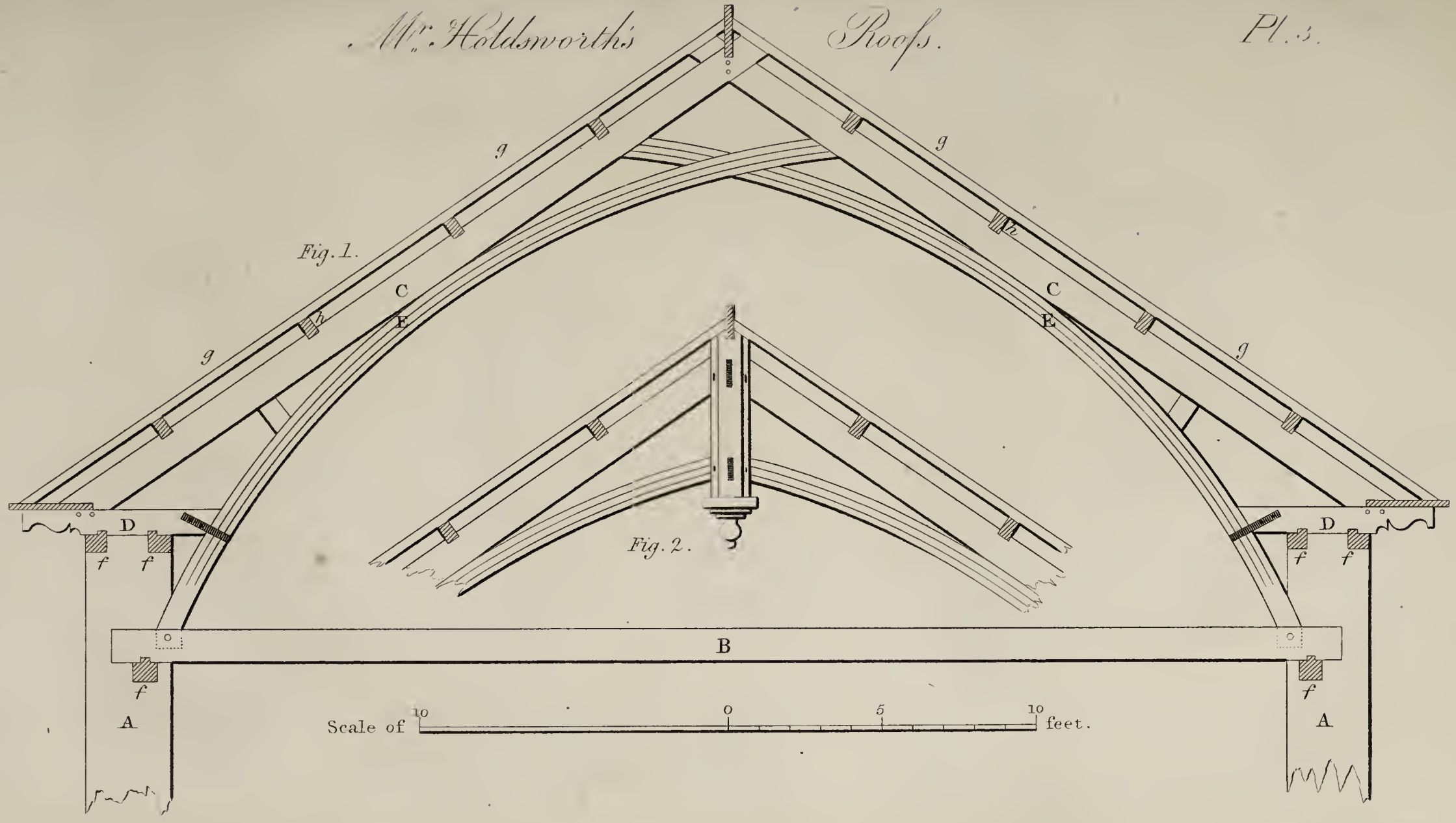
3 Mr. John Prior's Striking part of a Clock.



Drawn by C. Varley.

Engraved by J.B. Taylor.

Mr. Holdsworth's Roofs. Pl. 3.



Drawn & Presented by A. Ainger.

Engraved by J.B. Taylor.

Mr. Tho.s Austen's method of laying and adjusting the Bed Stone of a Corn-Mill.

Fig. 1.

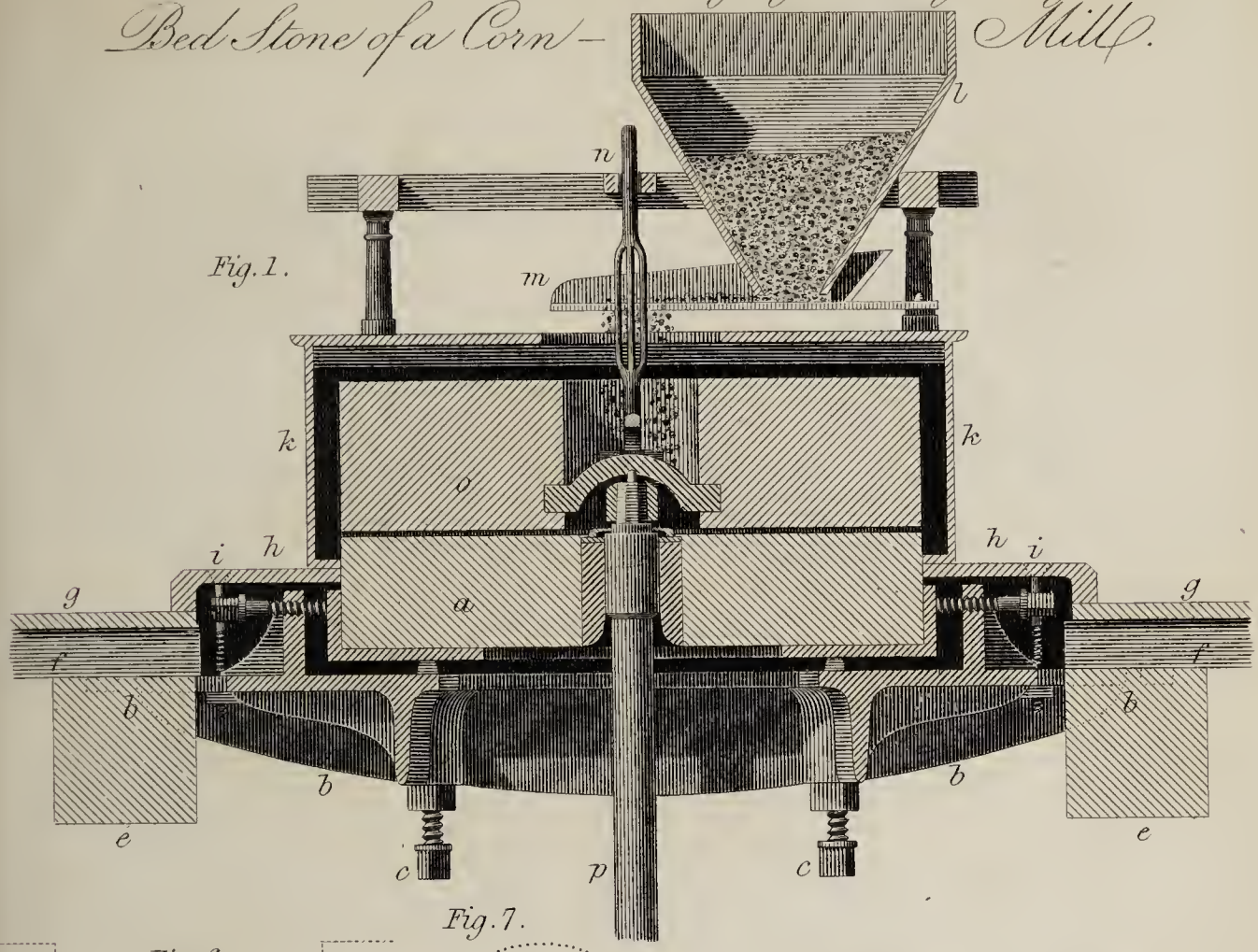
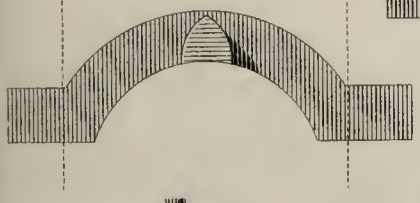
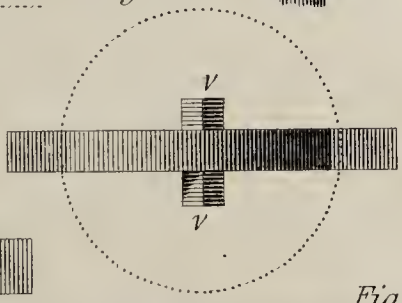


Fig. 7.

Fig. 6.





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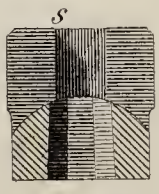

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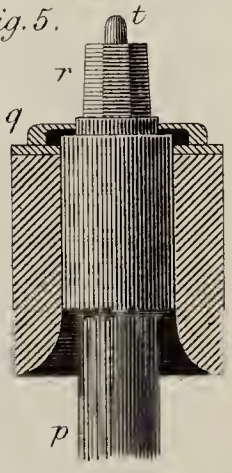

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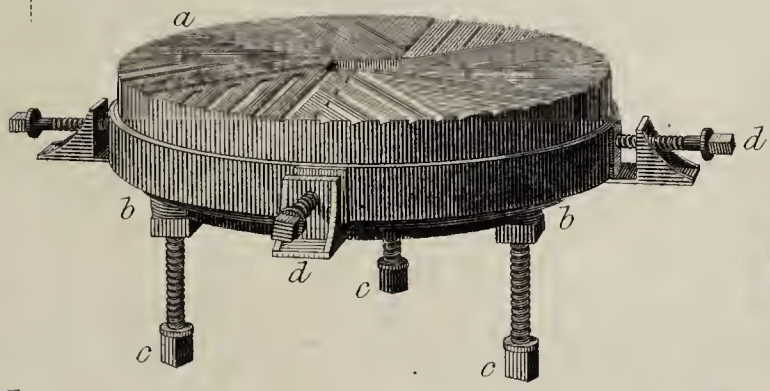

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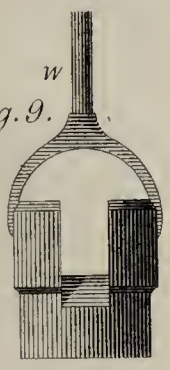

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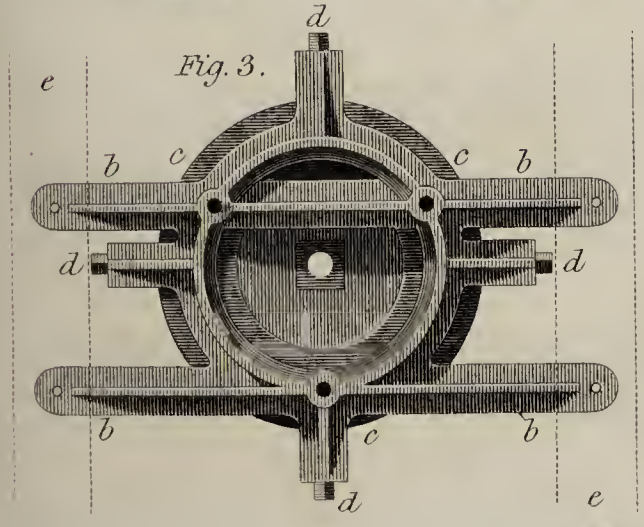

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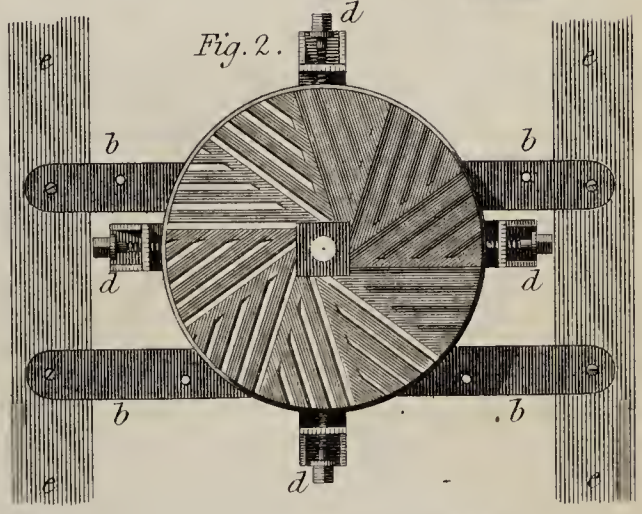
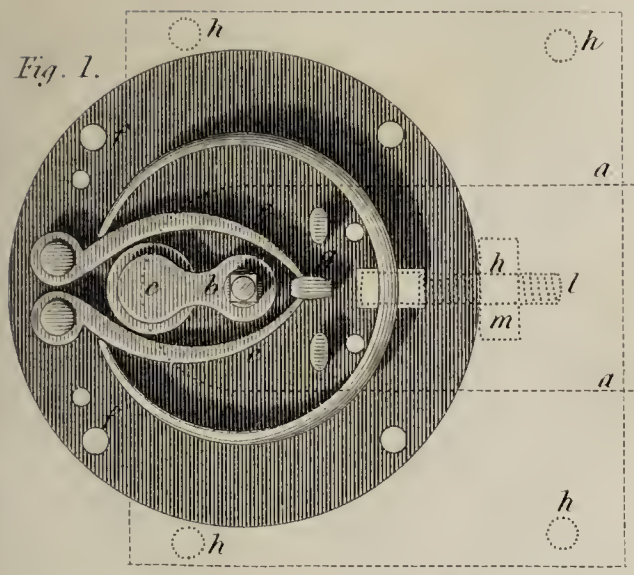


Drawn by C. Varley.

Engraved by J.B. Taylor.

Mr. I. White's, double Door Spring.

Fig. 1.



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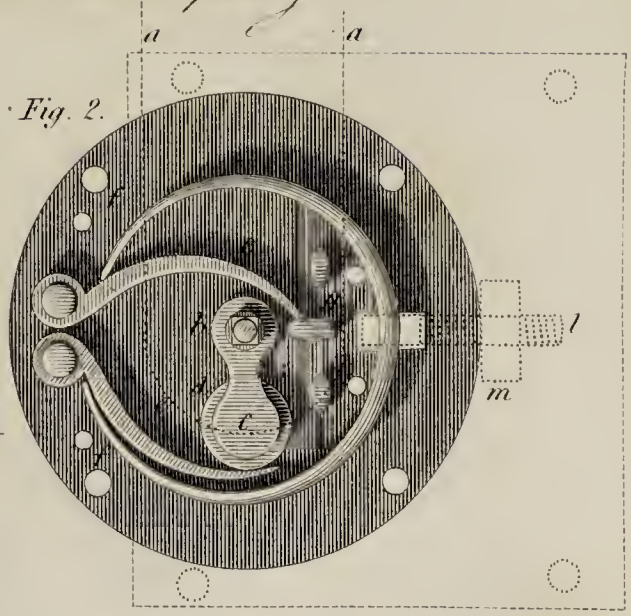
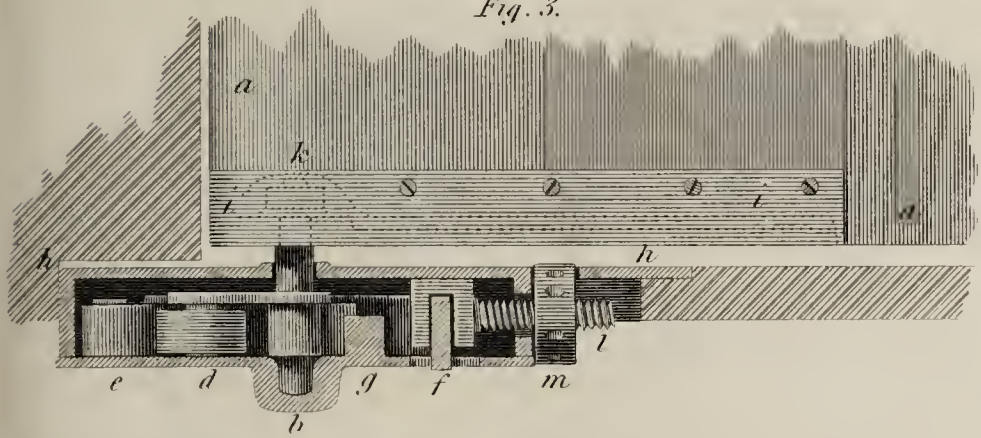


Fig. 3.



Mr. Smith's, Umbrella joint.

Fig. 6.

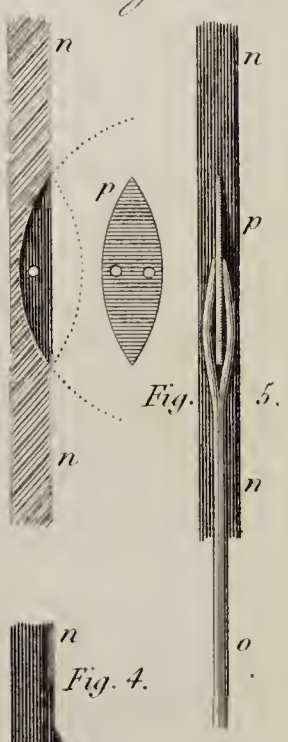


Fig. 5.

Mr. A. P. Harrison's, parellel Rule.

Fig. 7.

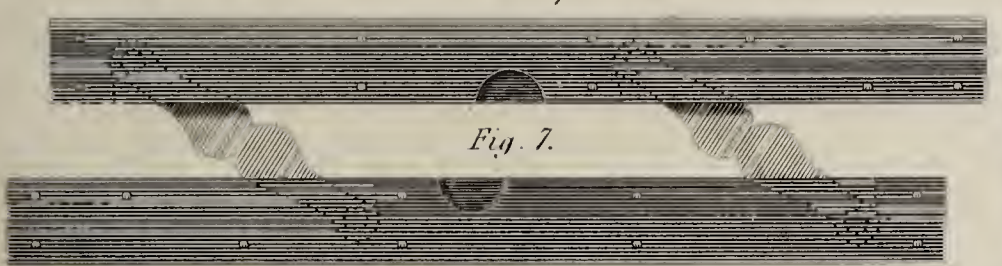
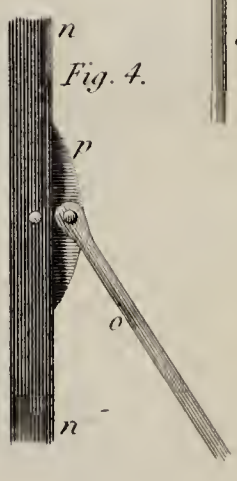


Fig. 10.

Fig. 9.

Fig. 4.



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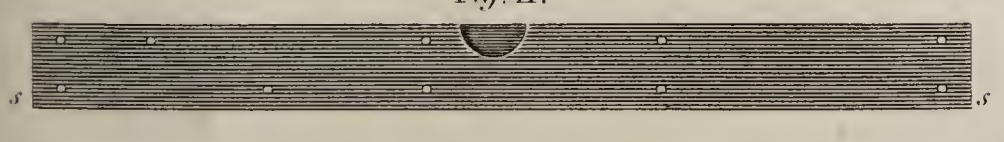

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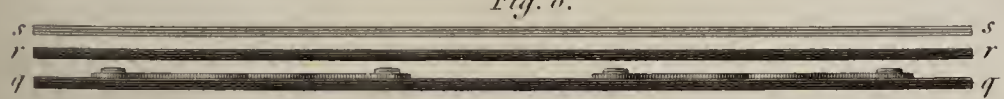


Drawn by Cornelius Varley.

Engraved by G. Gladwin.

Mr. J. Skinner's Machine for sweeping Chimnies.

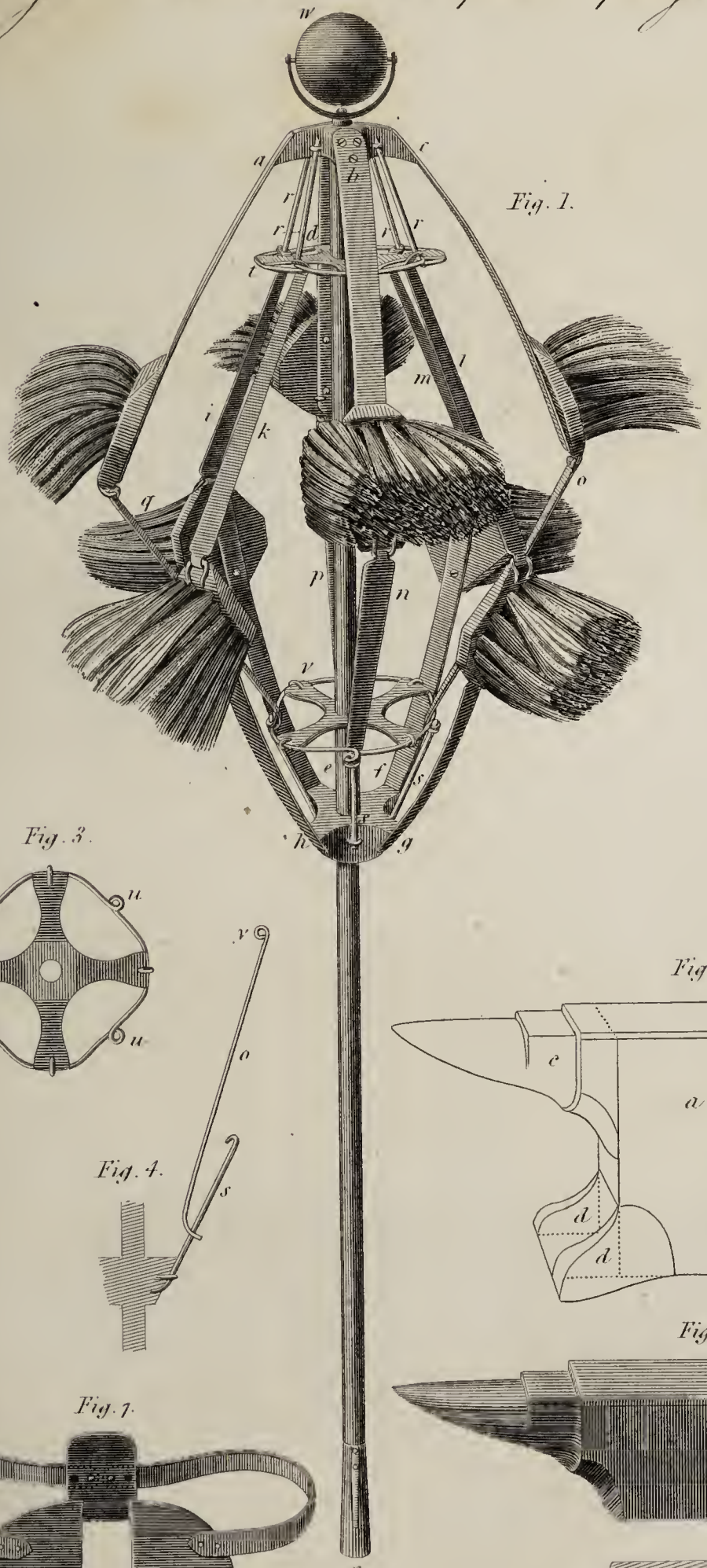
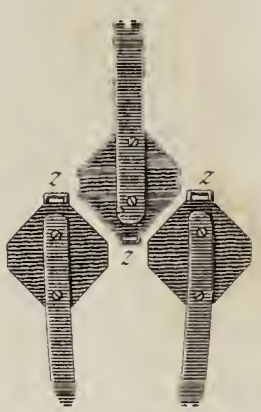


Fig. 1.

Fig. 2.



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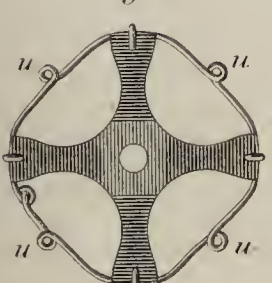

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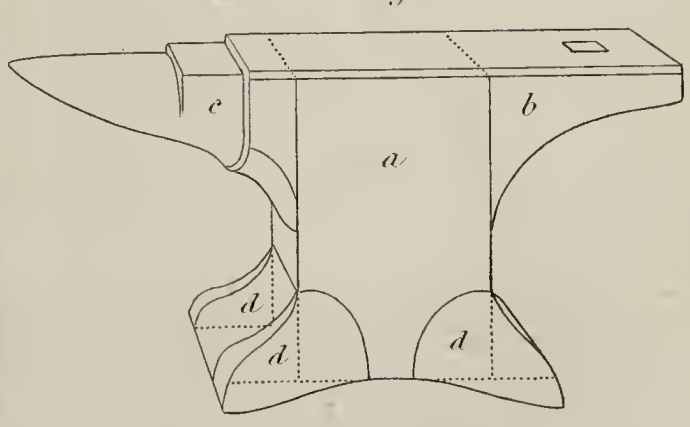

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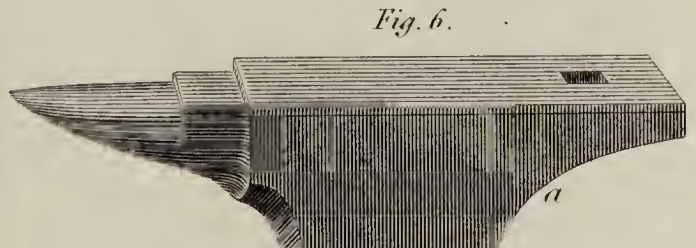

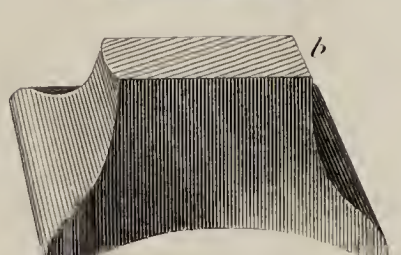

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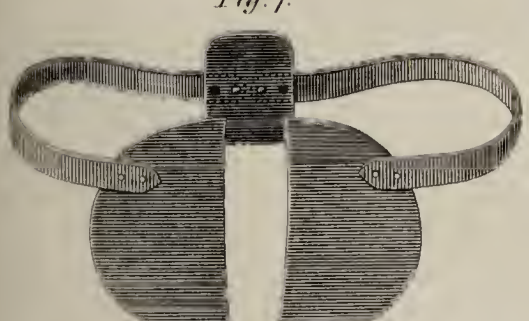


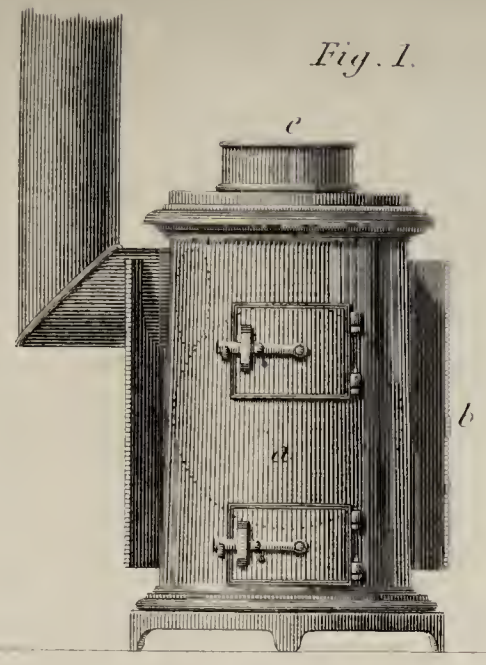
Mr. J. Gorman's Spring Bandage.

Mr. R. King's Anvil.

Cornelius Varley, del.

G. Gladwin, sculp.

Fig. 1.



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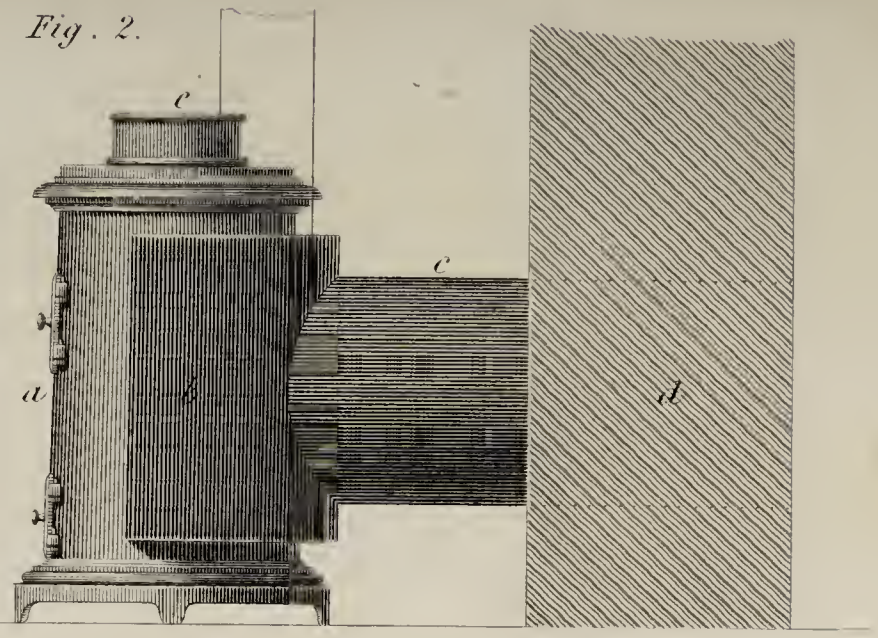


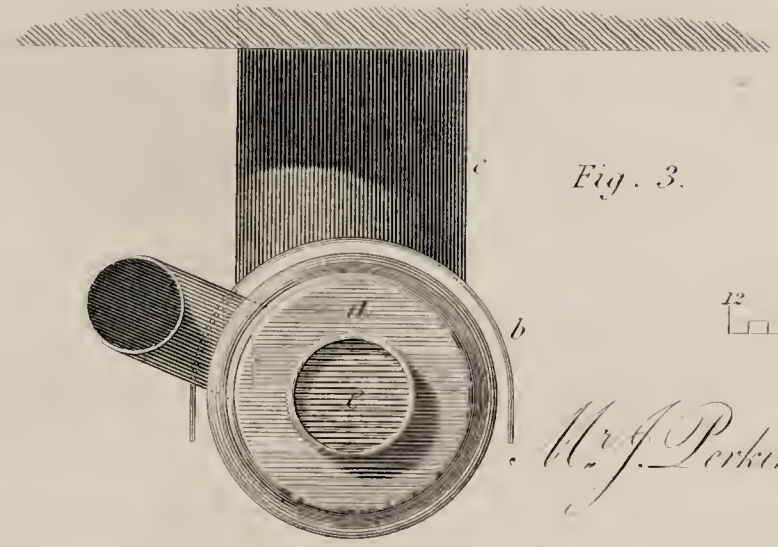
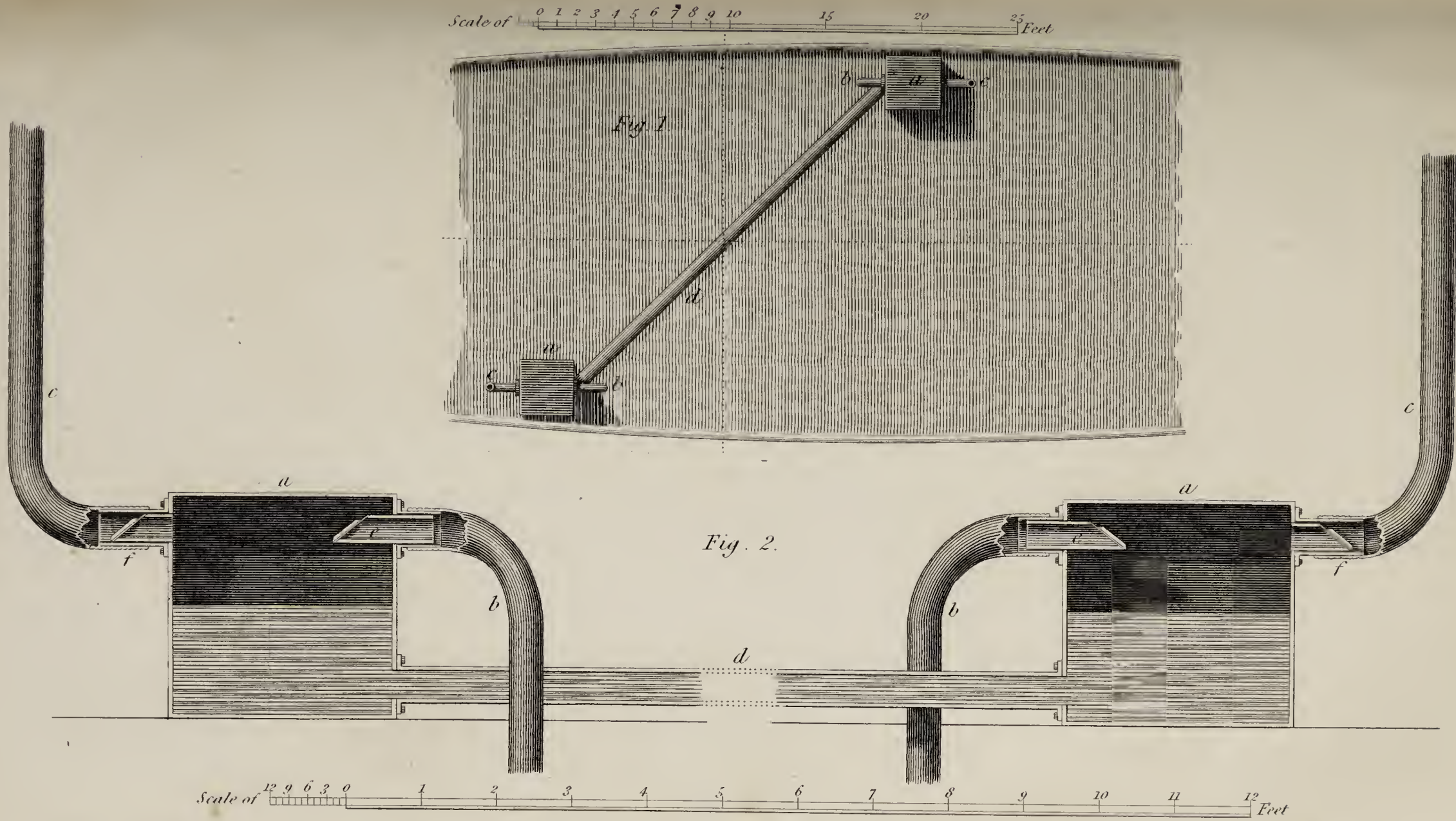


Fig. 3.

Mr J. Perkins's method of Ventilating & Warming Apartments or Workshops.

Drawn by J. Pinchback.

Engraved by G. Gladwin.



Drawn by J. Pinchback.

Engraved by G. Gladwin.

Mr. J. Perkins's method of Ventilating the holds of Ships.

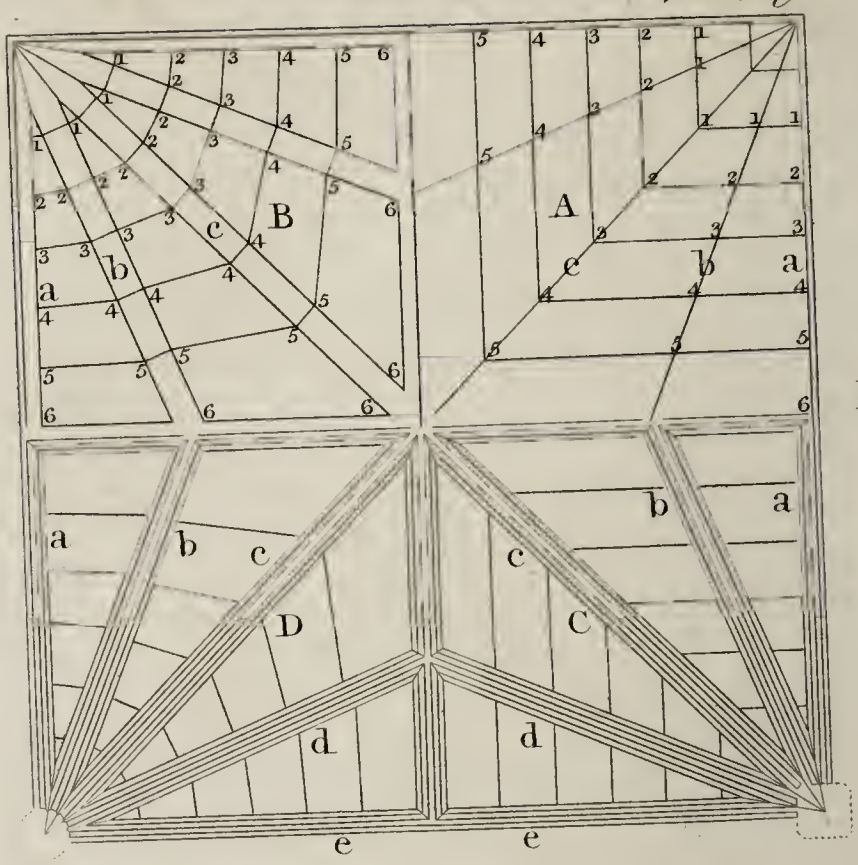
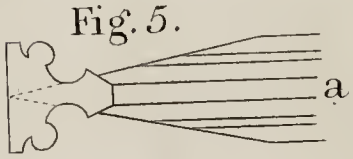


Fig. 1.

Fig. 5.



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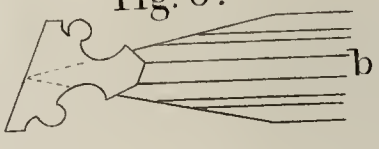

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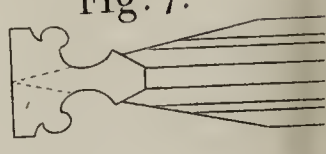


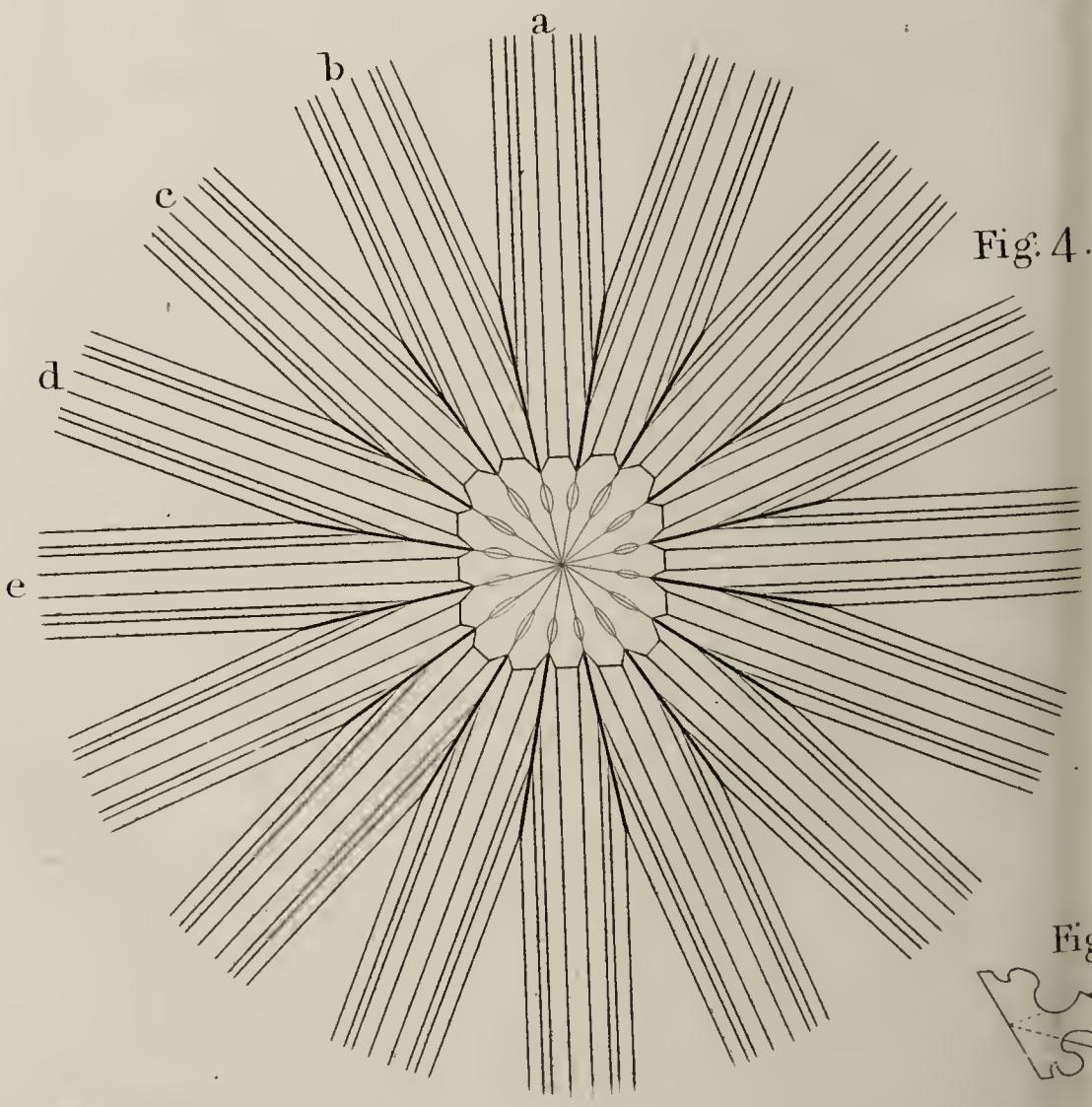
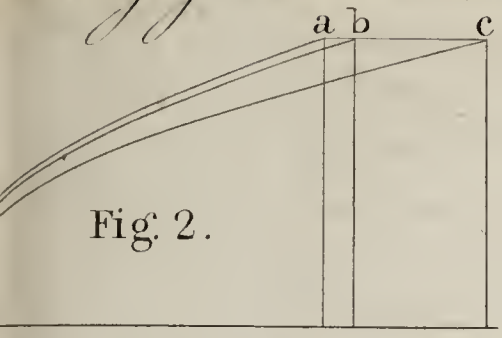


Fig. 4.

Fig

Drawn by J. Jopling



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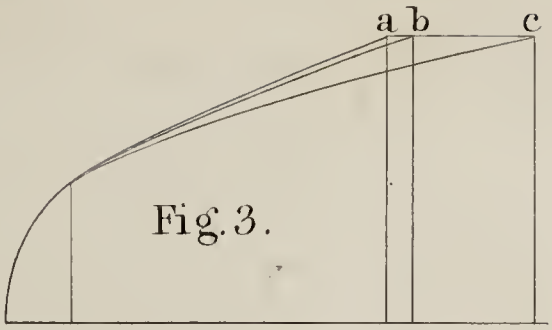

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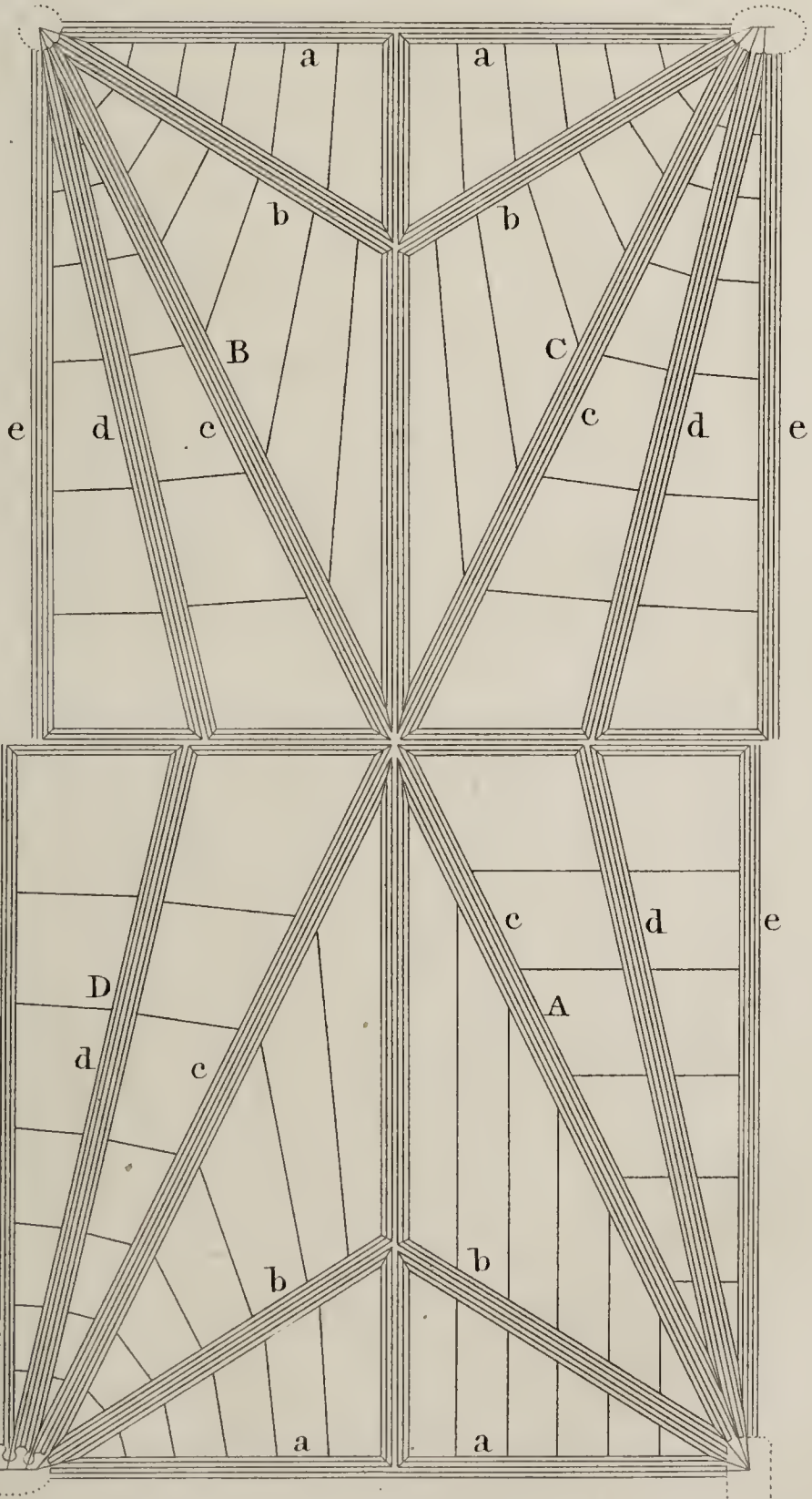


Fig. 15.

Fig. 11.

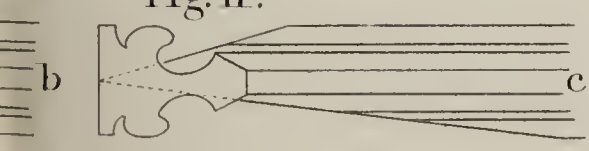
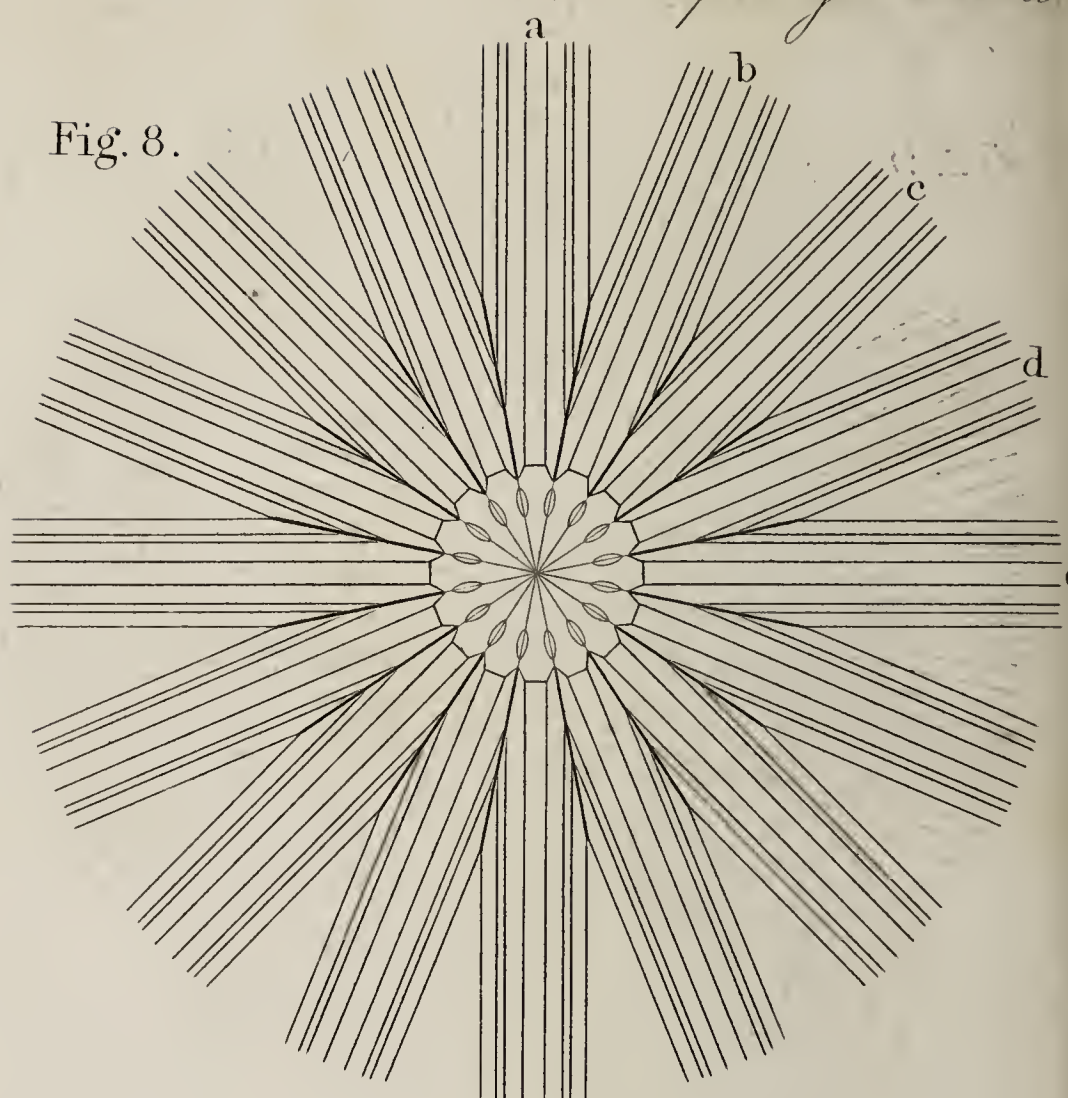


Fig. 12.

Engraved by J.B. Taylor.

Fig. 8.



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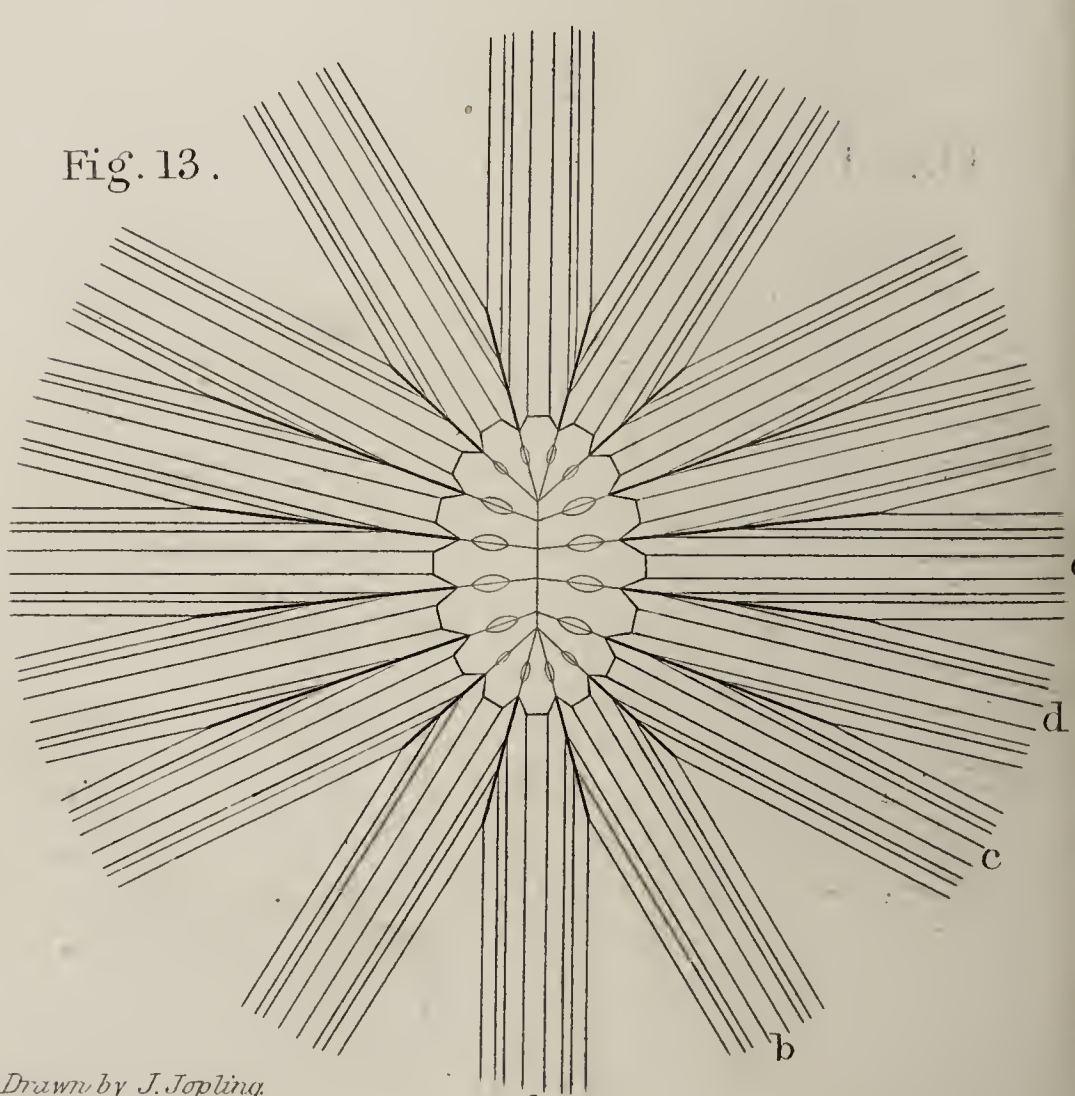
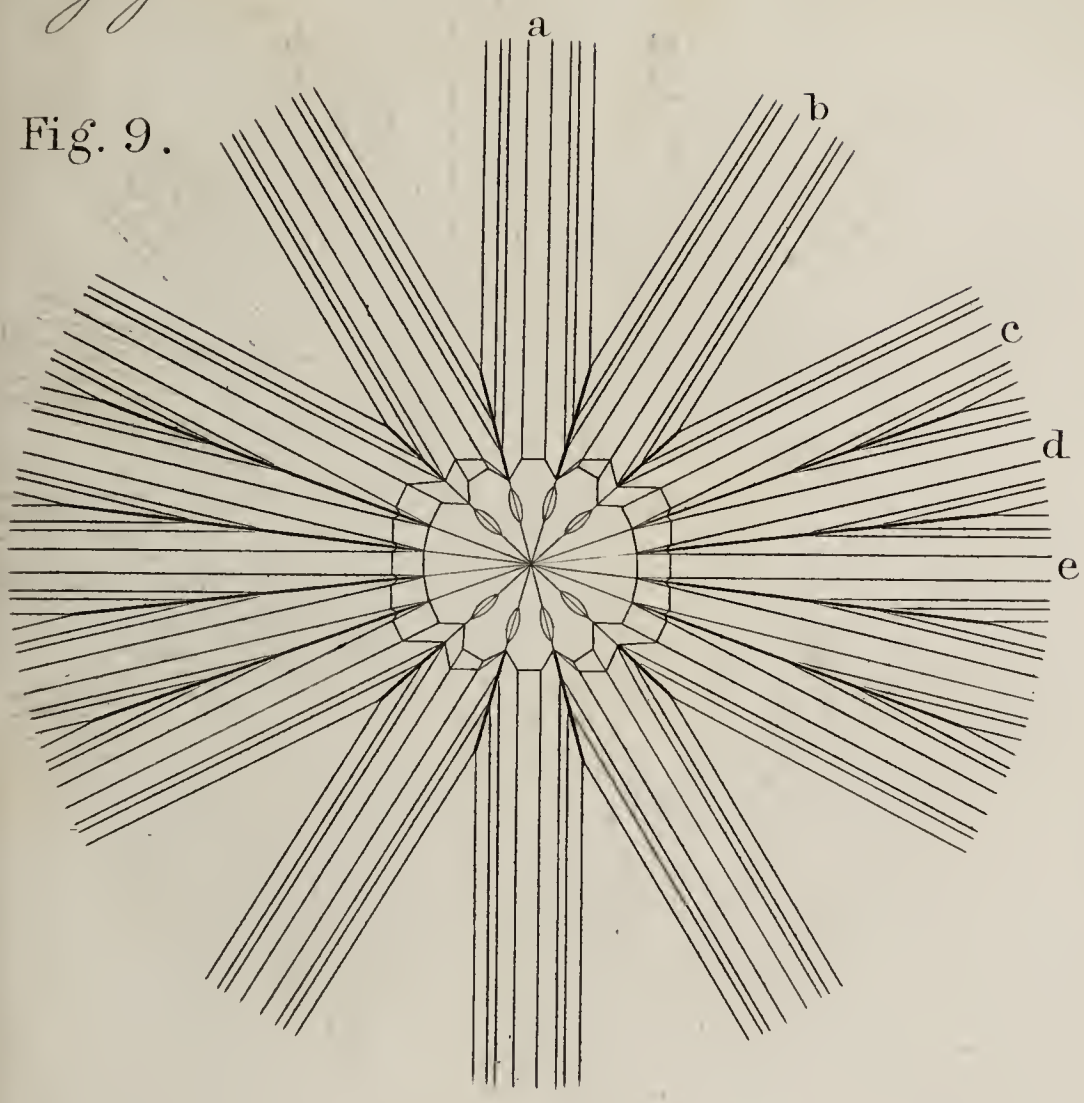


Drawn by J. Jopling.

Fig. 9.



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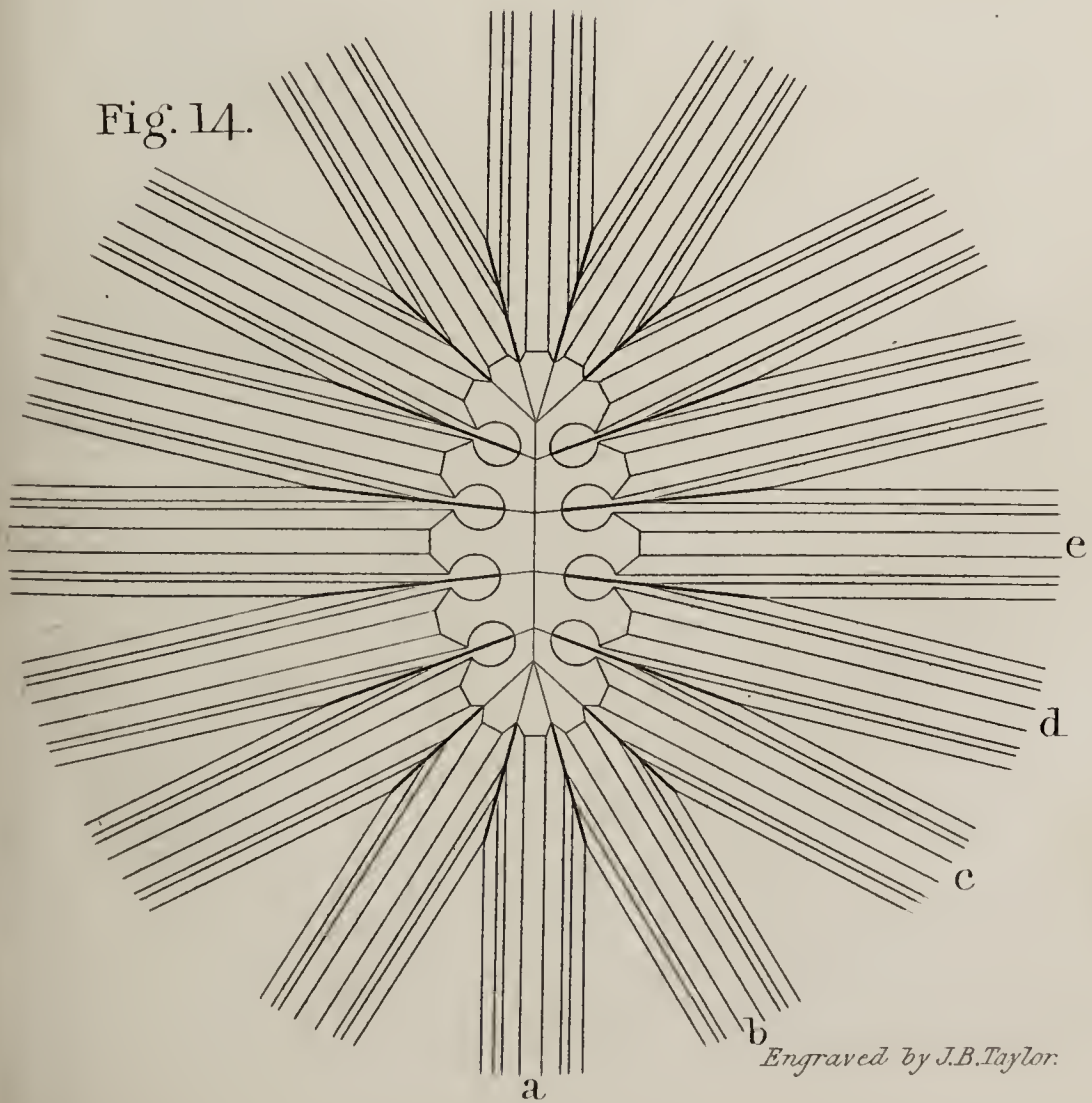
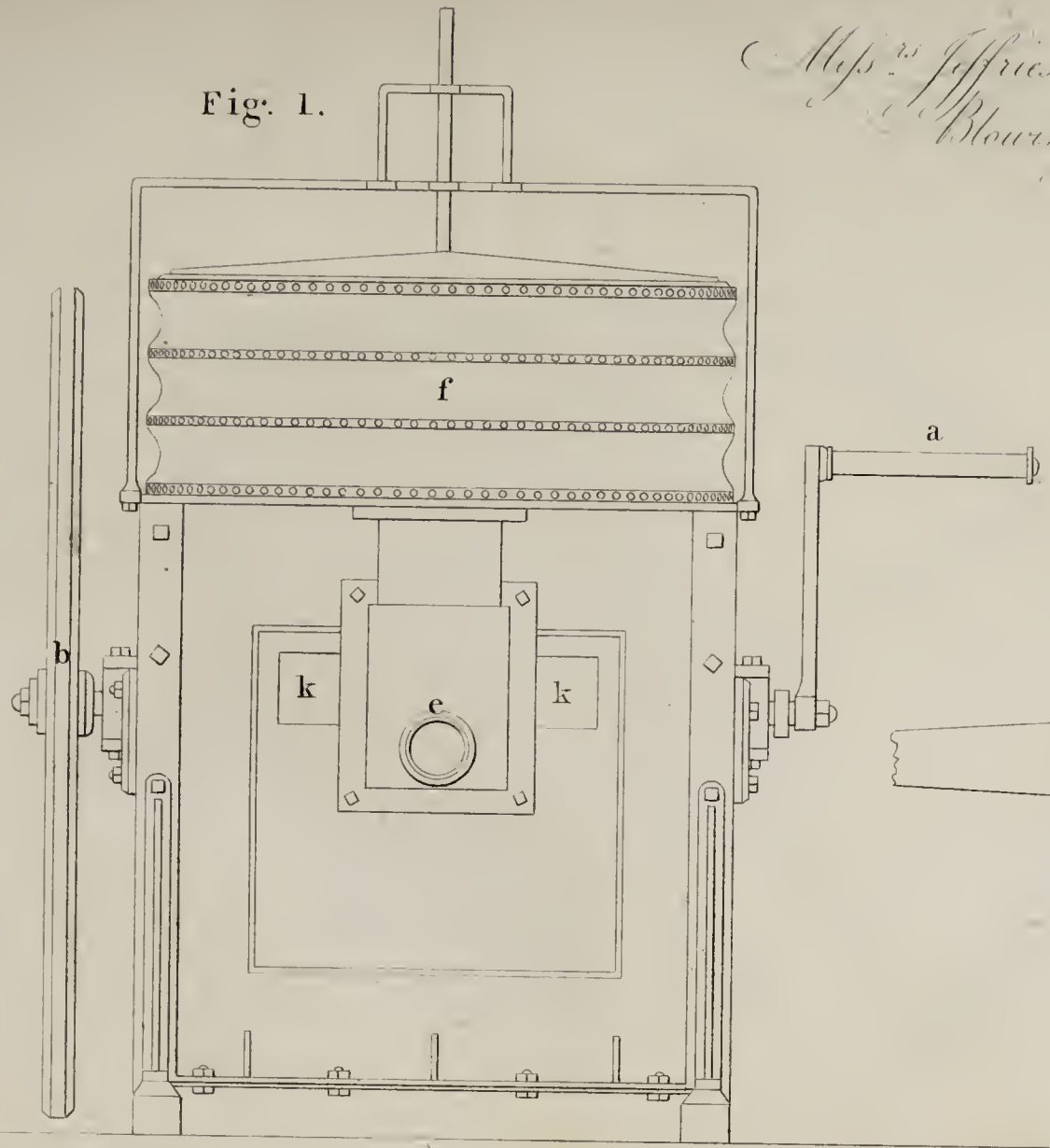


Engraved by J.B.Taylor.

Mess.rs Jeffries and Halley's Blowing Machine.

Fig. 1.



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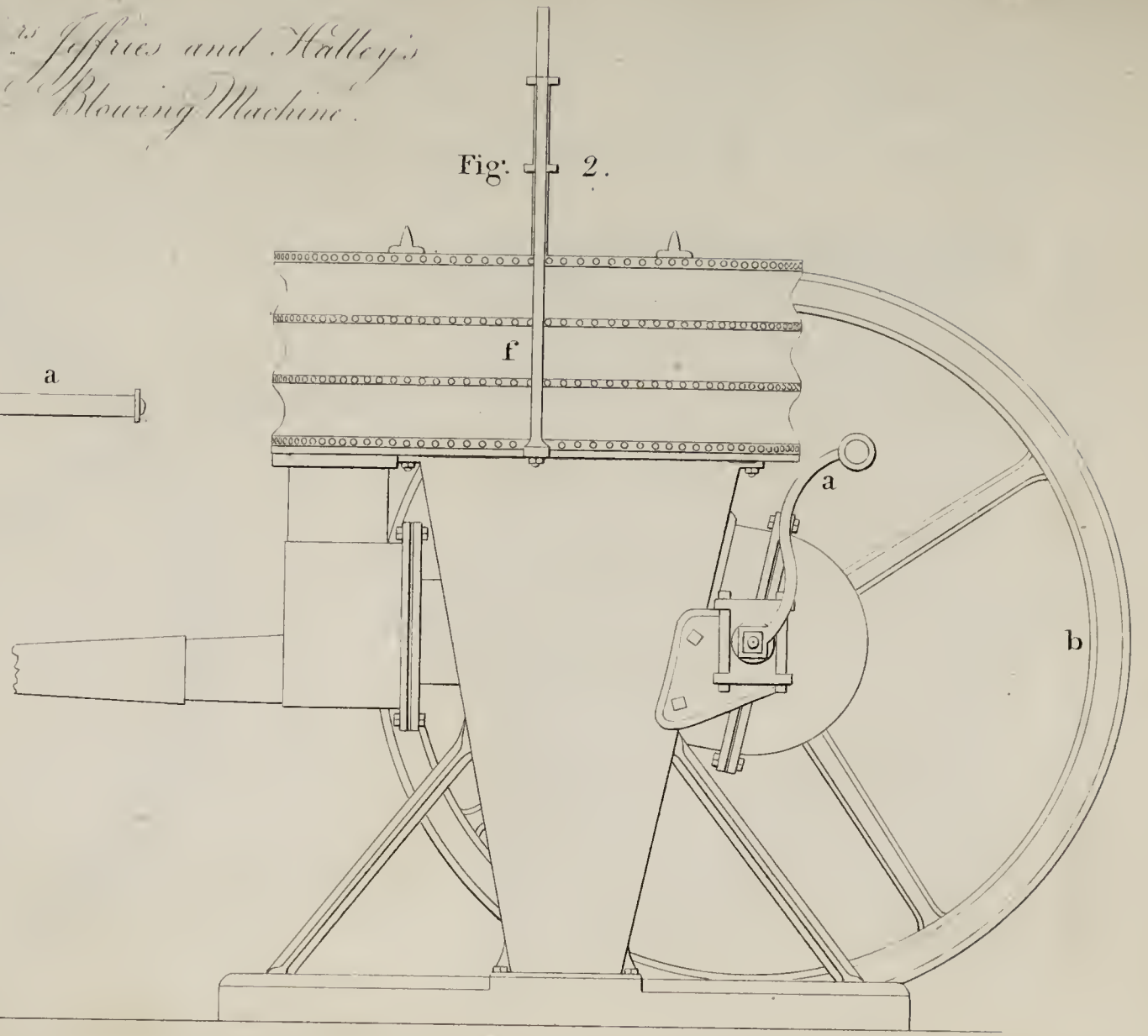
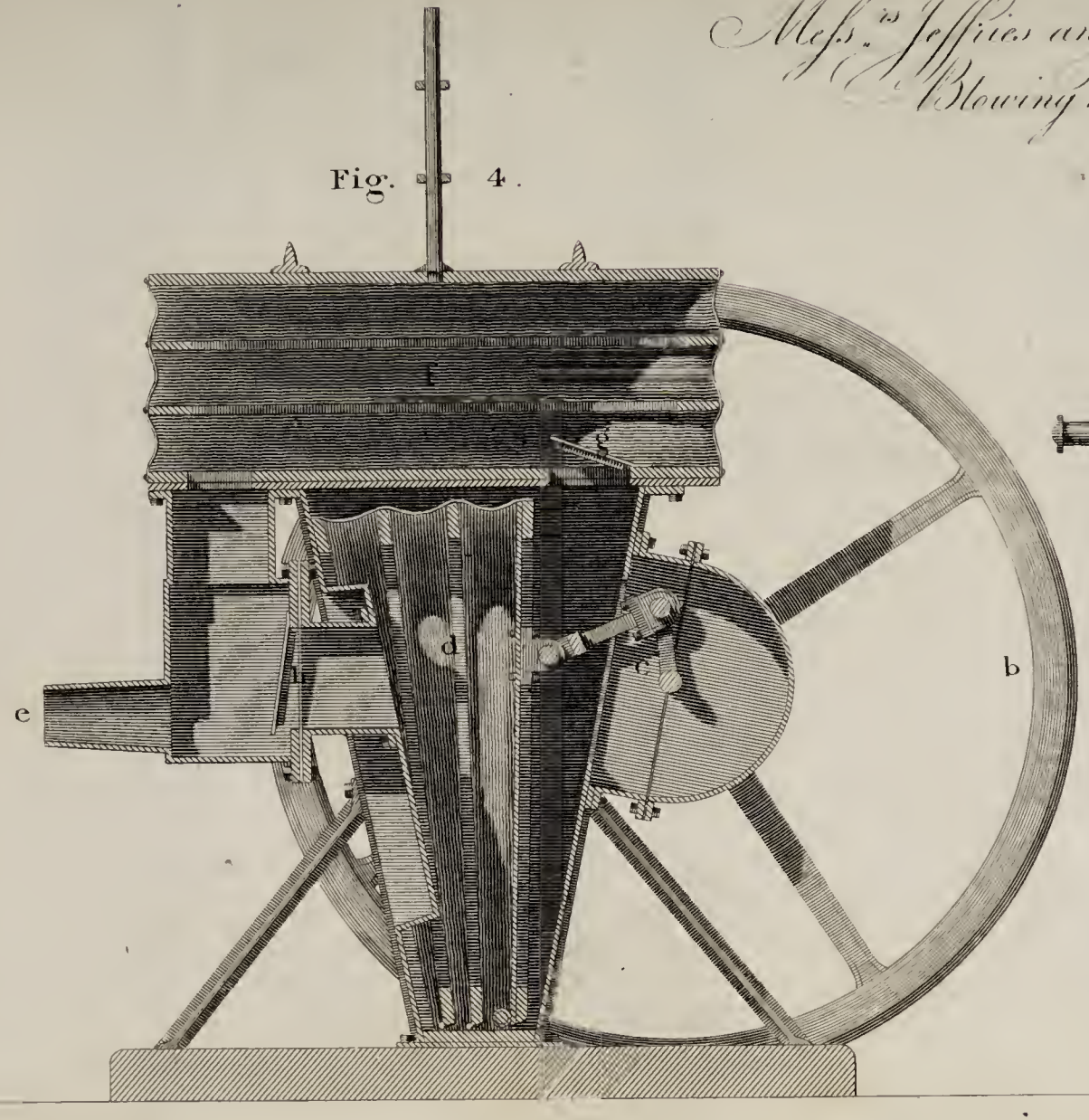


Drawn by W. Newton

Engraved by S. Porter.

Messrs. Jeffries and Halley's Blowing Machine.

Fig. 4.



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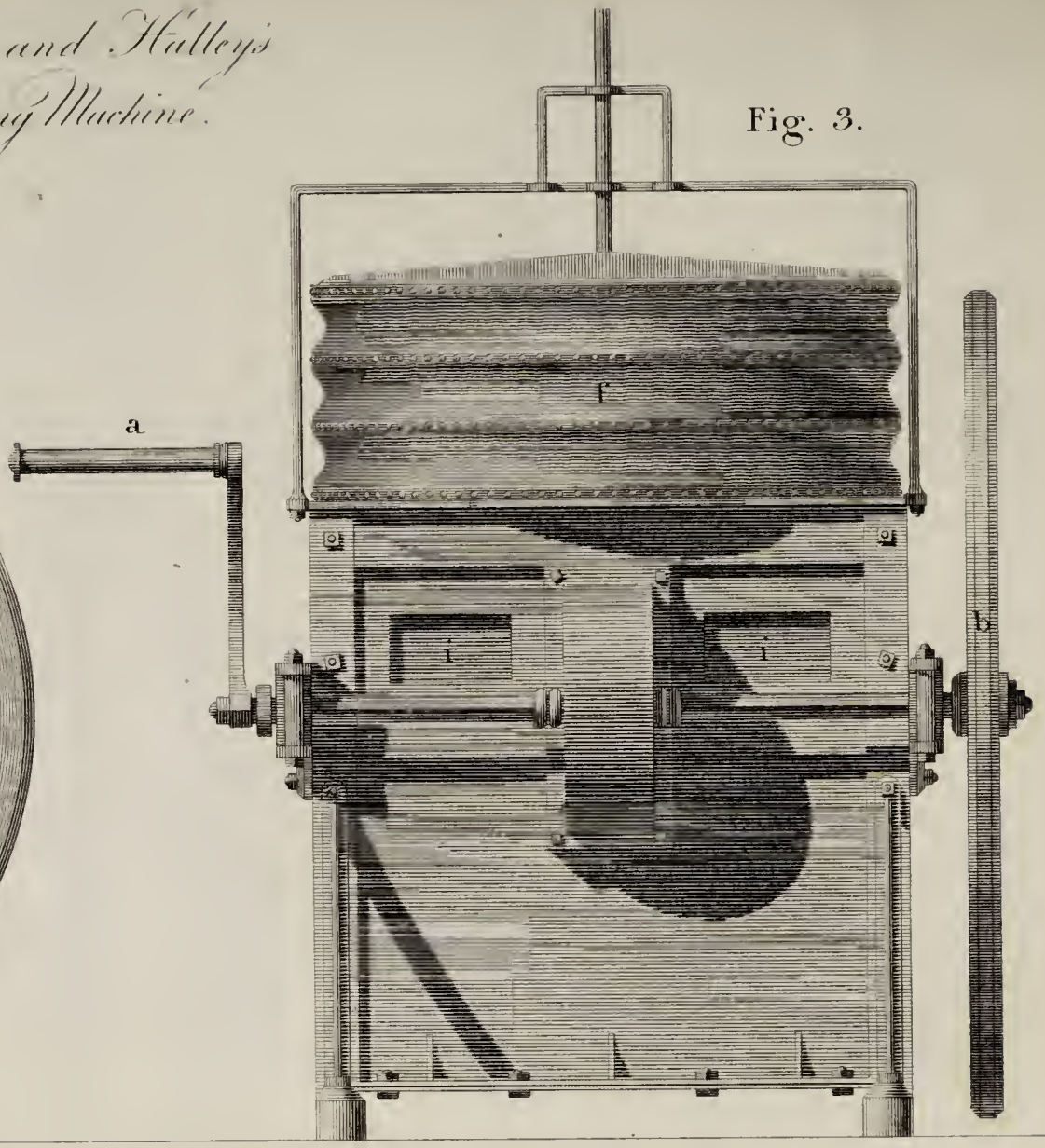
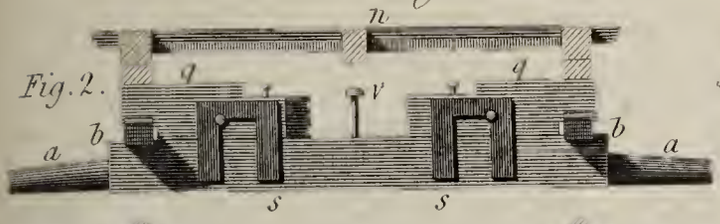


Drawn by W. Newton.

Engraved by S. Porter.

Mr. F. C. Cherry's moveable spring & blocks for carts. Plate.



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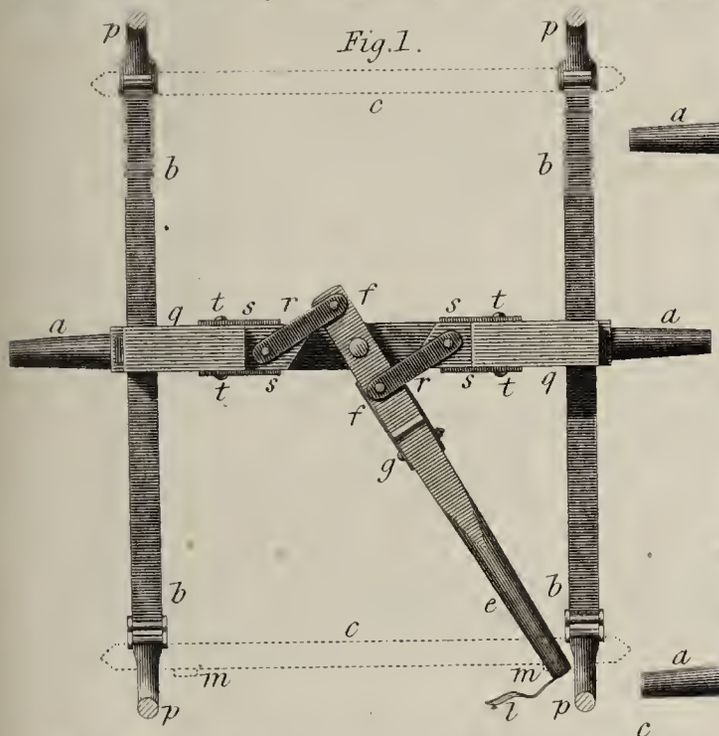
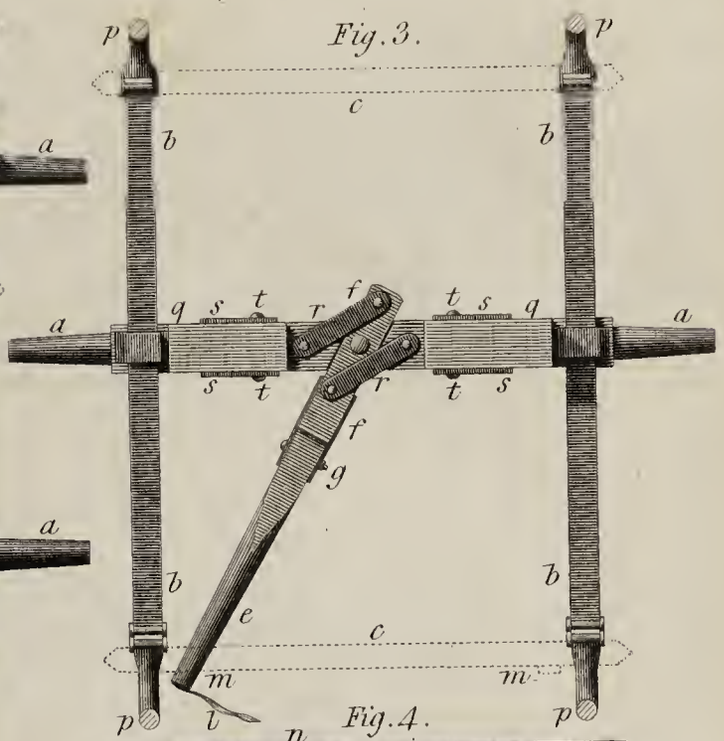


Fig. 1.



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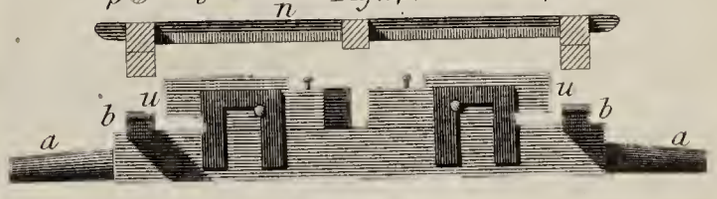

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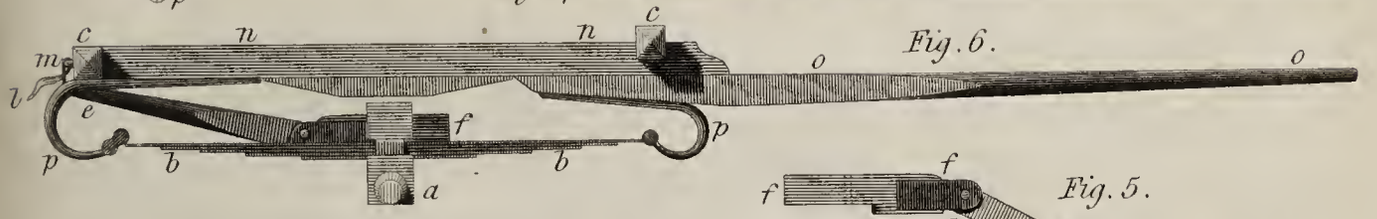

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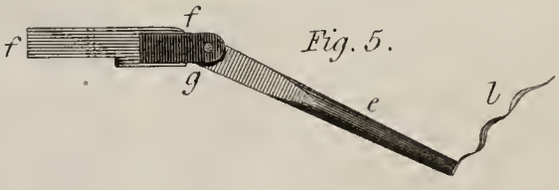

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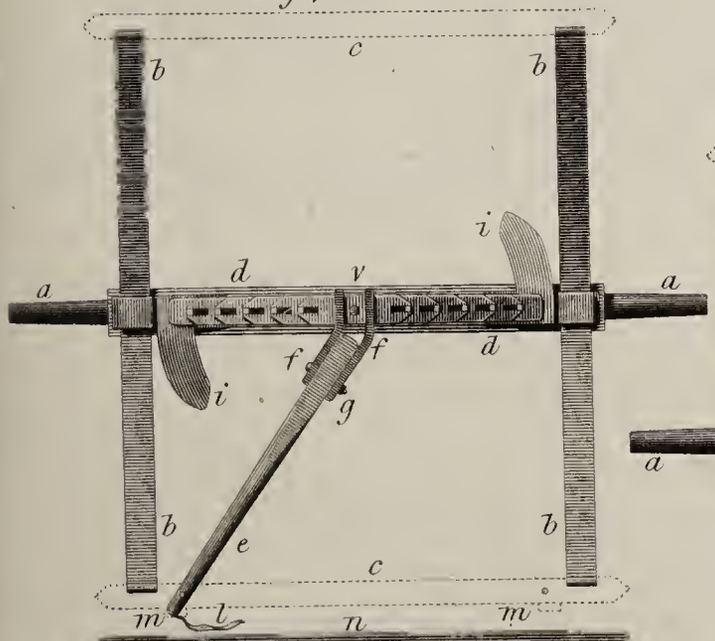

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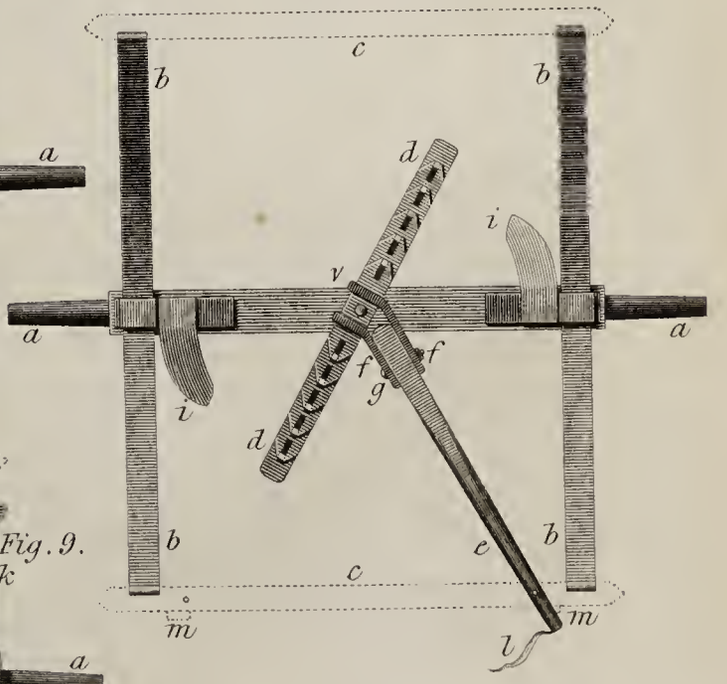

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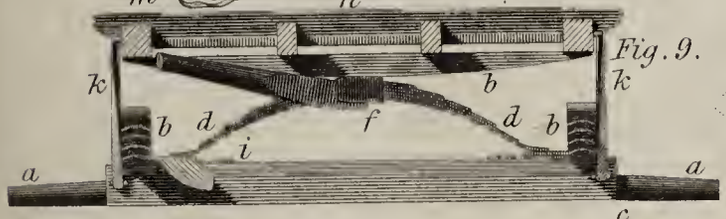


Fig. 9.

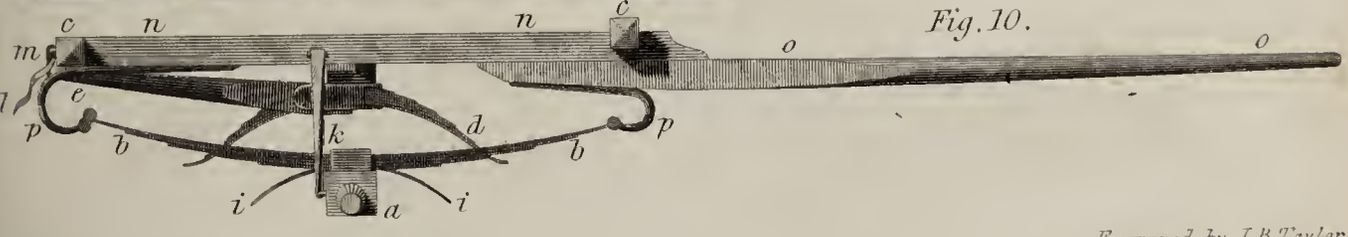


Fig. 10.

Drawn by C. Varley.

Engraved by J. B. Taylor

Mr. A. Ainger's Lock. Pl. 14.

Fig. 5. Fig. 6.

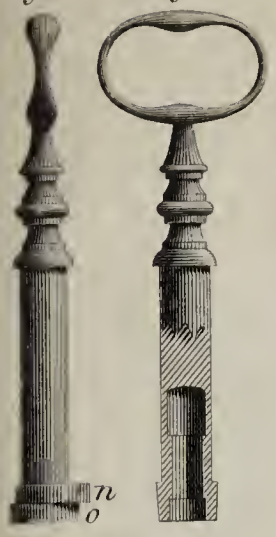
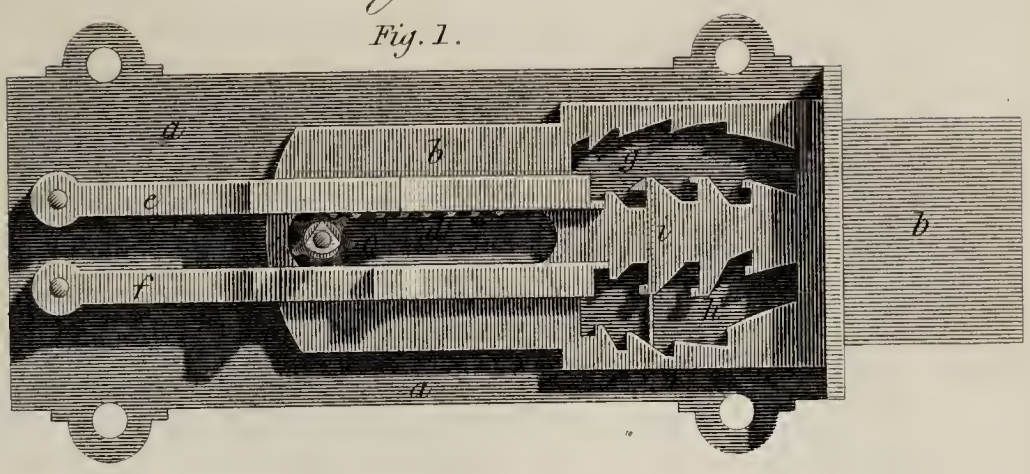


Fig. 1.



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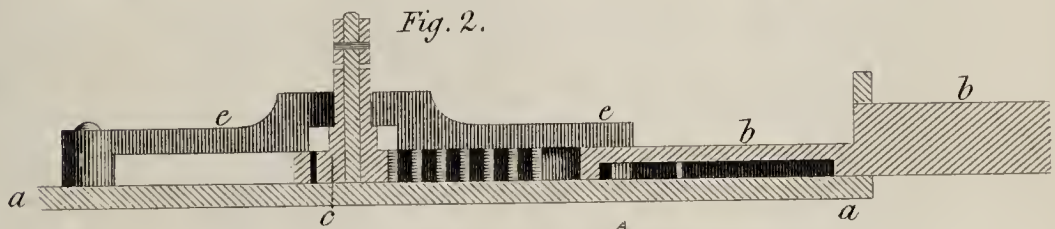

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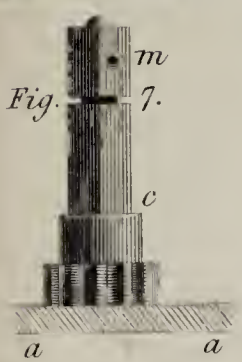

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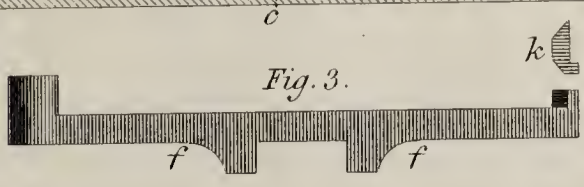

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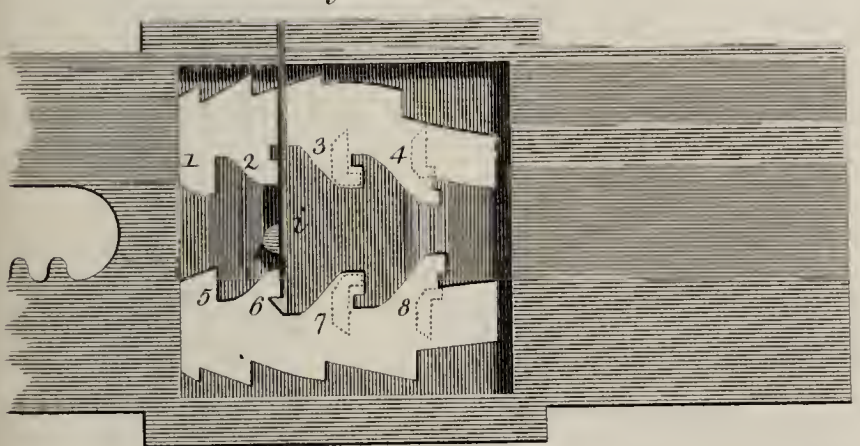

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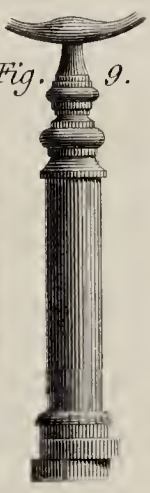


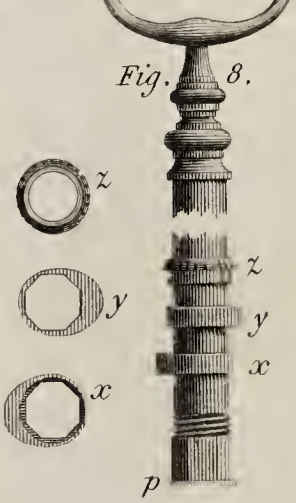


Fig. 8.

Fig. 10.

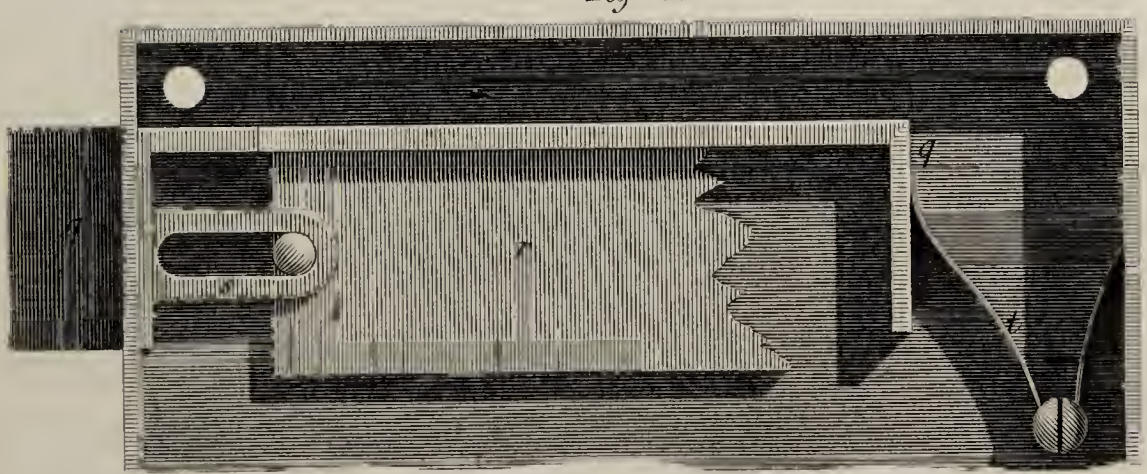


Fig. 11.

Drawn by A. Ainger.

Engraved by J.B. Taylor.

Mr H. C. Jennings's Log Glass.

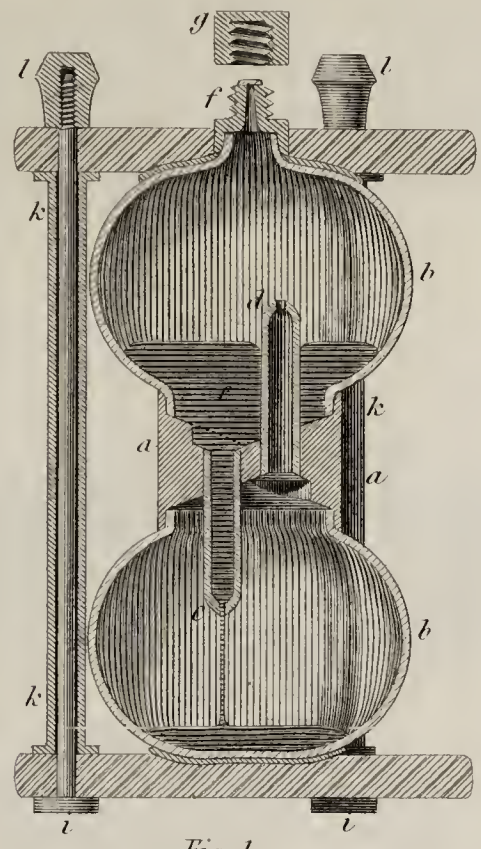


Fig. 1.

Fig. 5.

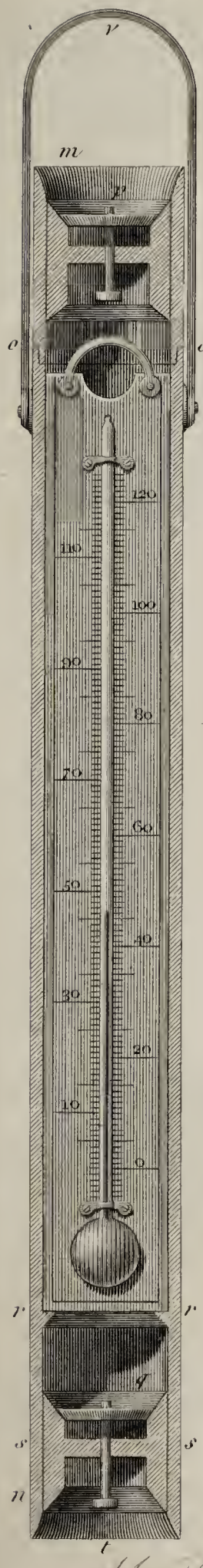
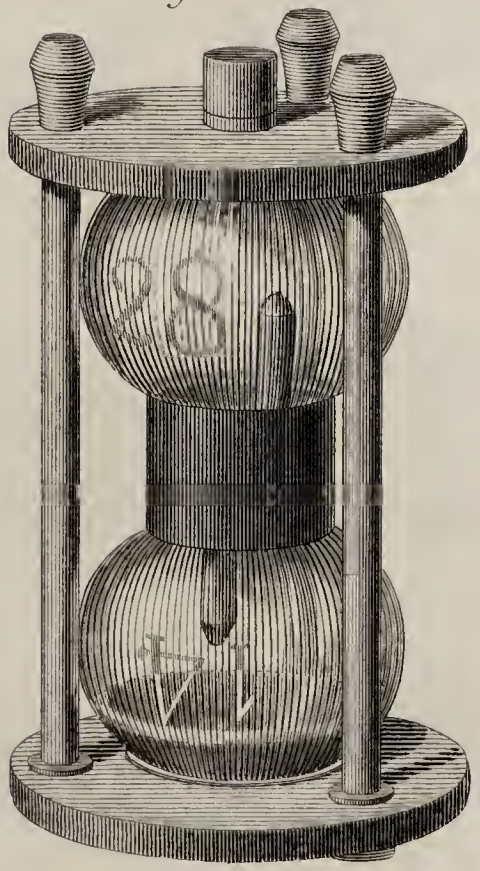


Fig. 3.

Fig. 2.



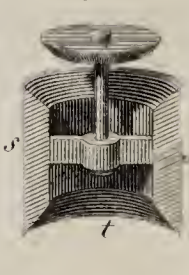


Fig. 4.

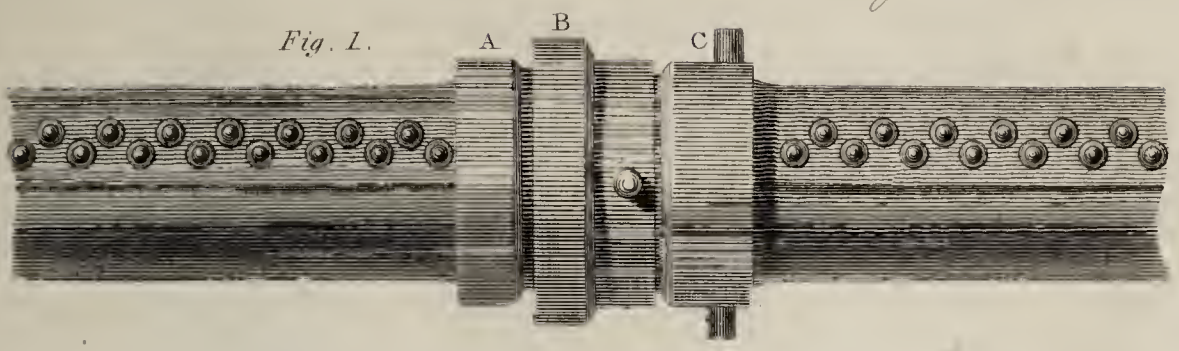
Mr R. Jamieson's Marine Thermometer Case.

Drawn by Cornelius Varley.

Engraved by G. Gladwin.

Mr. I. Perkins's Hose for Fire Engines.

Fig. 1.



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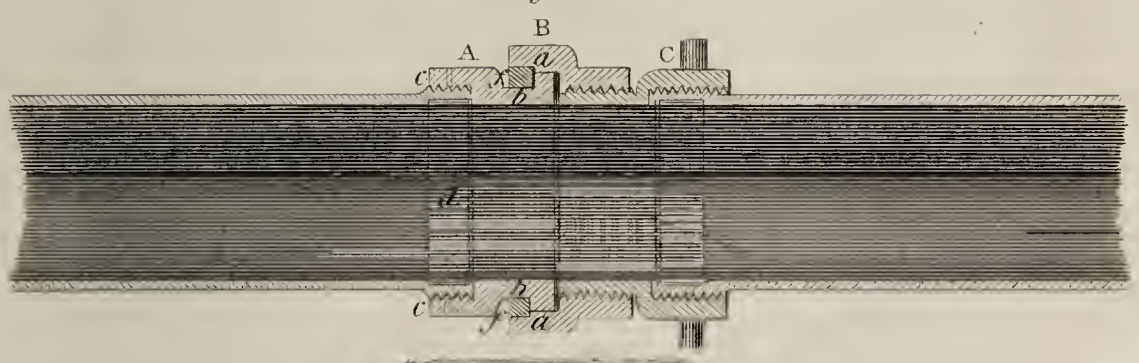

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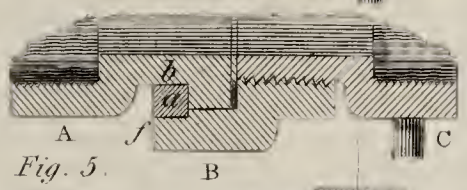
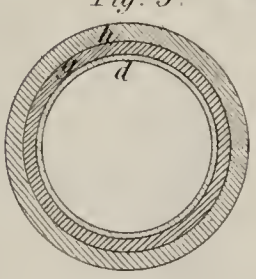


Fig. 4.

Fig. 5.



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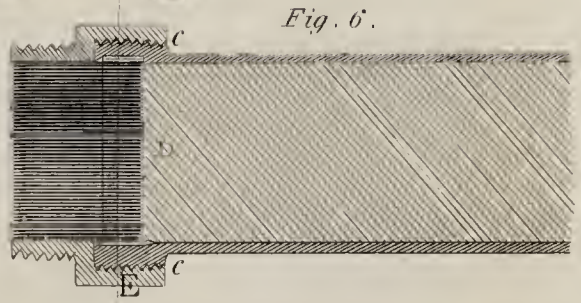
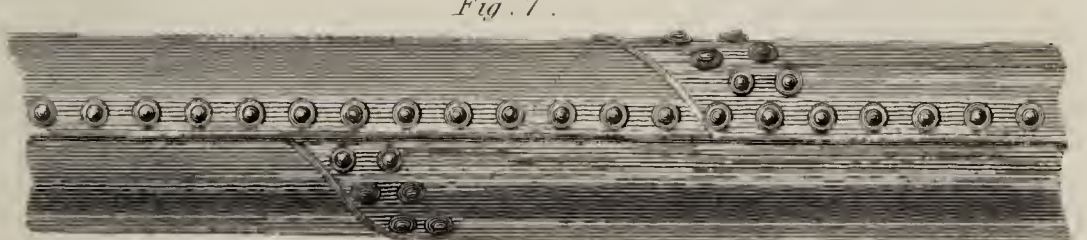


Scale 3 In = 1 Ft.

Fig. 7.



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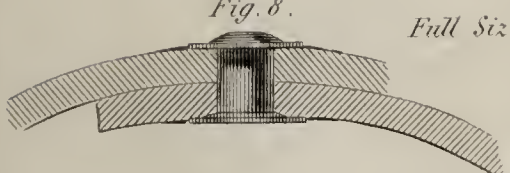


Full Size.

Fig. 9.

Drawn by Pinchback.

Engraved by A.W. Warren.

Mr. I. Perkins's Ship's Pump.

Fig. 1.

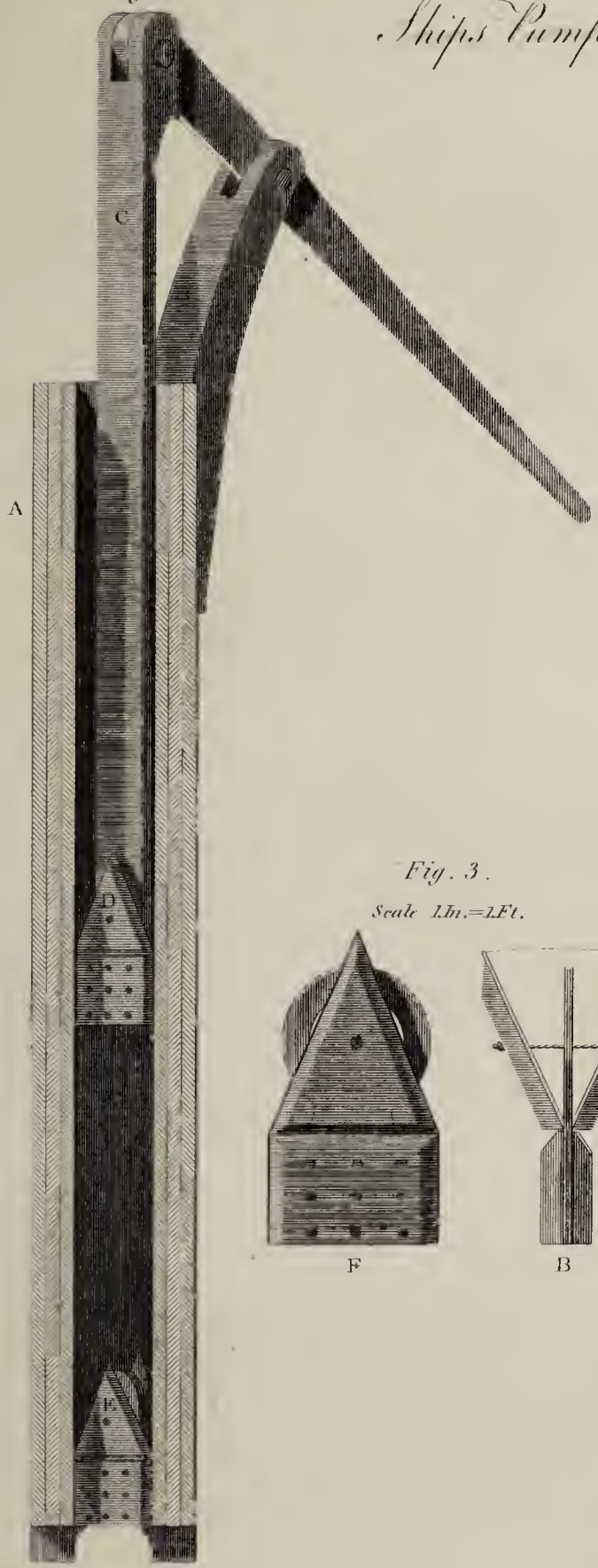


Fig. 2.

Fig. 3.

Scale 1 In. = 1 Ft.

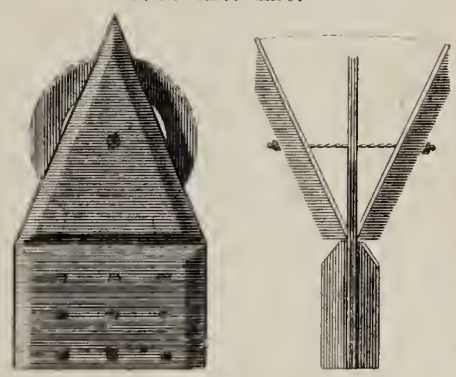
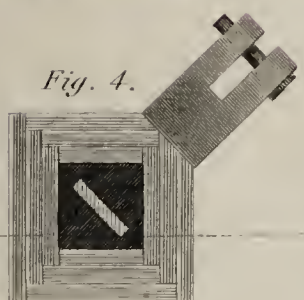


Fig. 4.



Scale 3/8. = 1 Ft.

Fig. 5.

Drawn by Pinchback.

Engraved by A.W. Warren.

Mr R. P

Fig. 1.

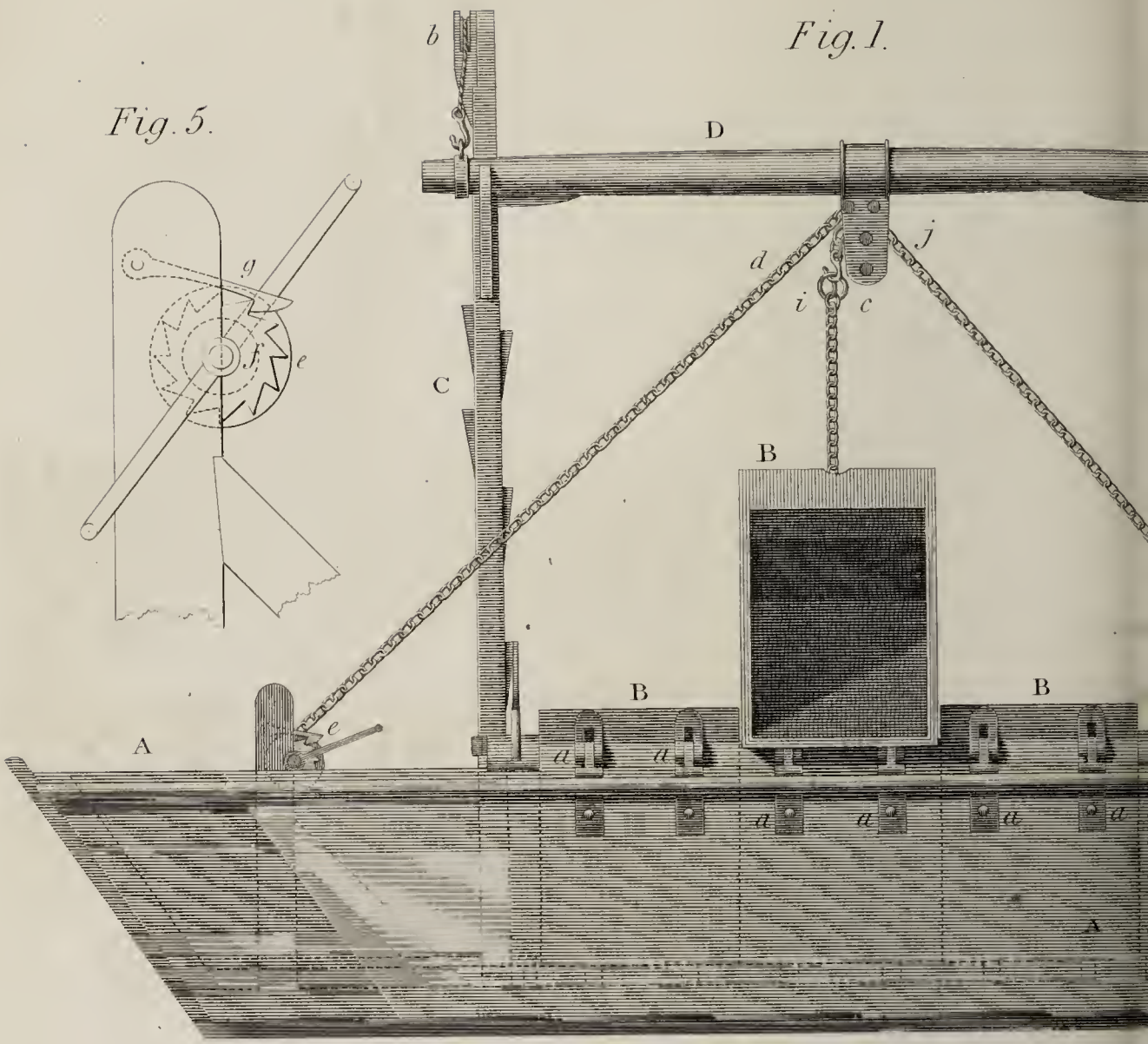
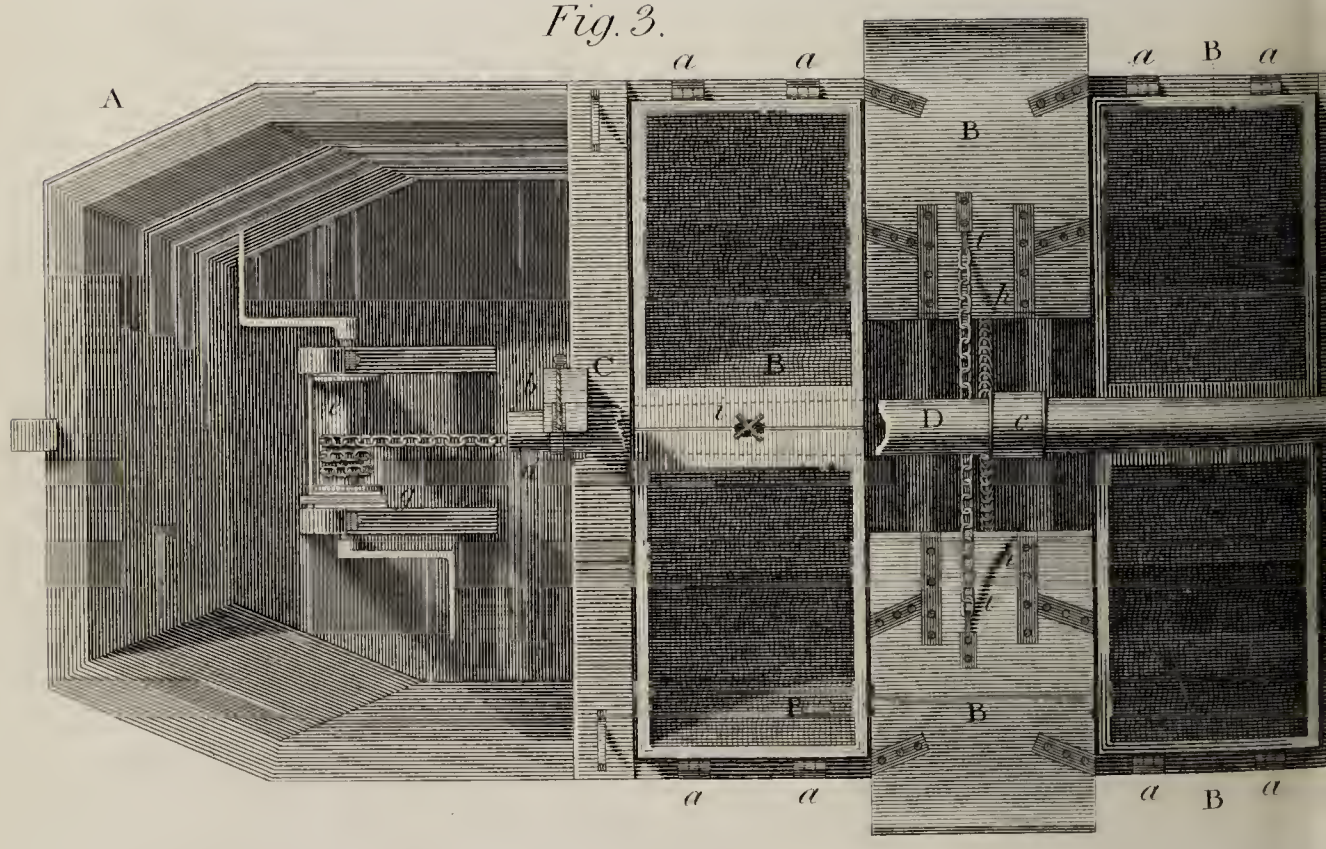


Fig. 5.

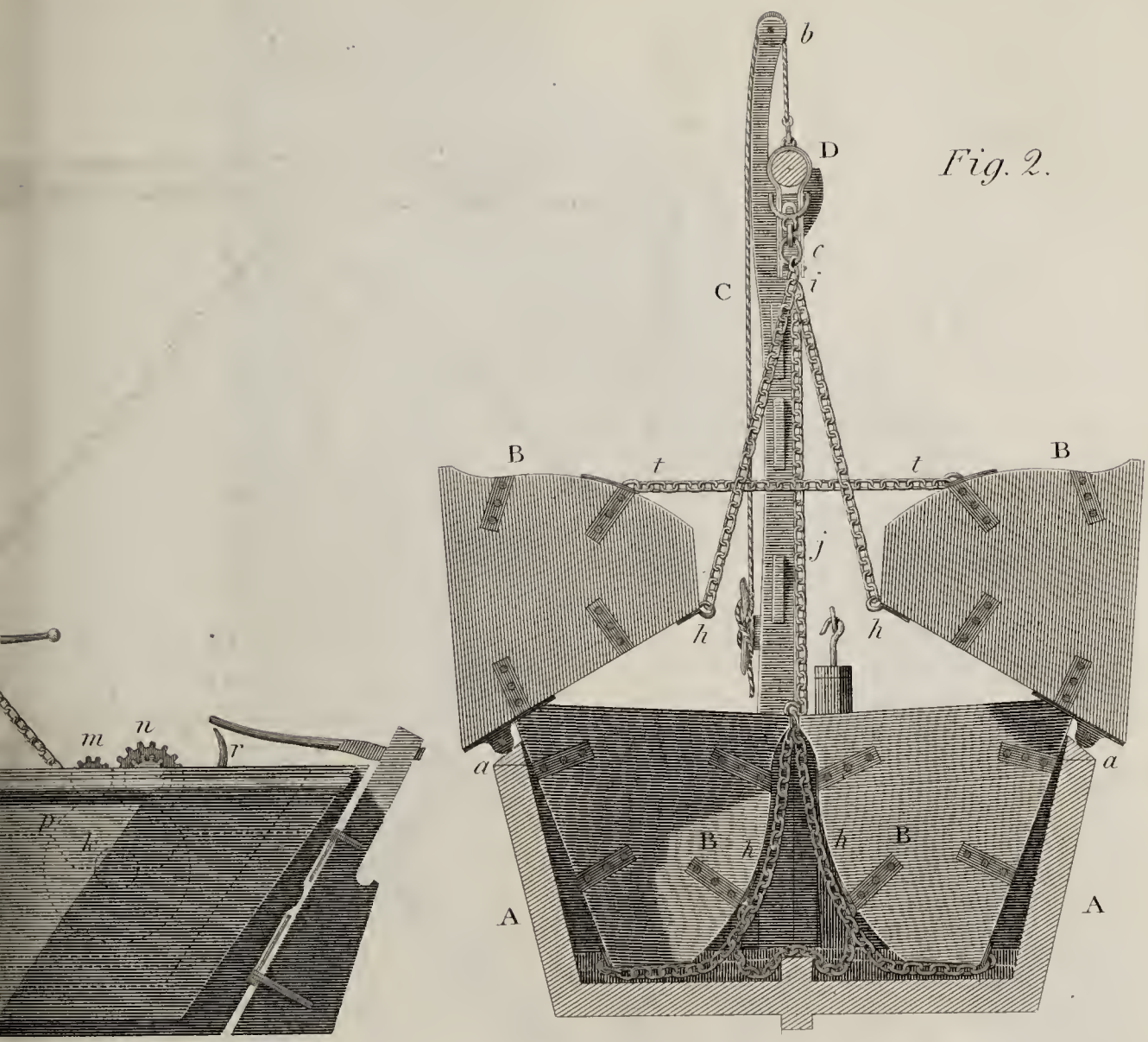
Fig. 3.



Drawn by J. Clement.

Mud-boat.

Plate XVIII.



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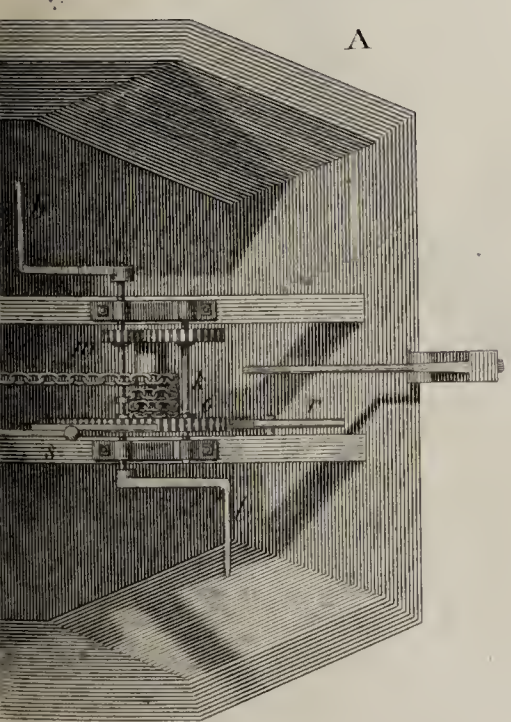

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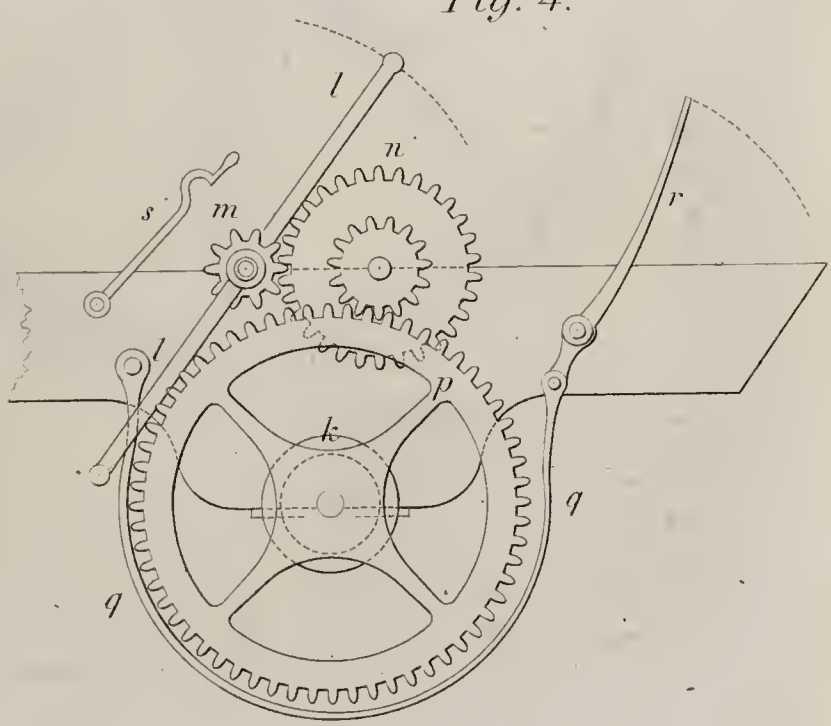
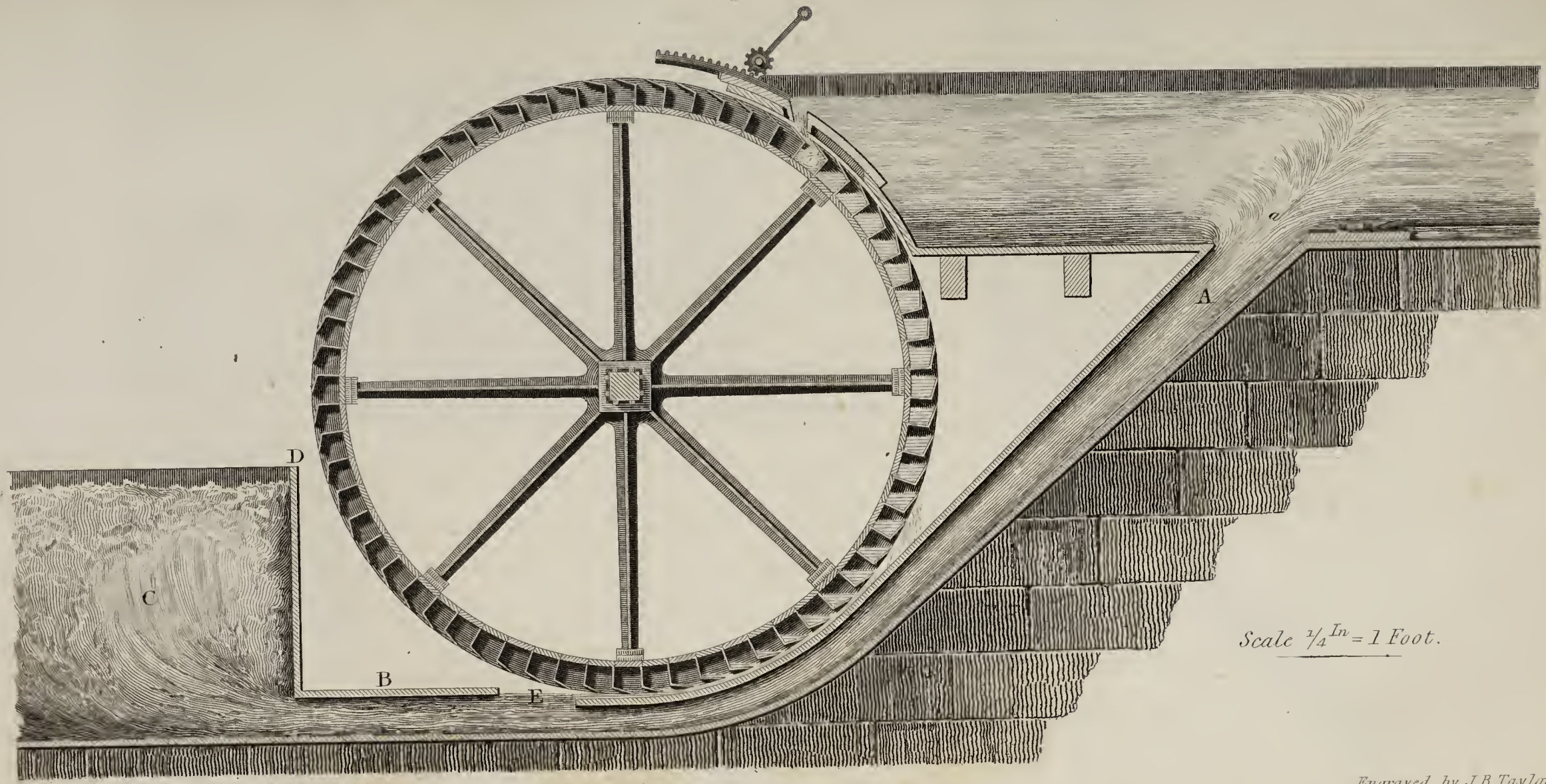


Engraved by J. Davis

Mr. J. Perkins's method of freeing water-wheels from back-water. Pl. 19.

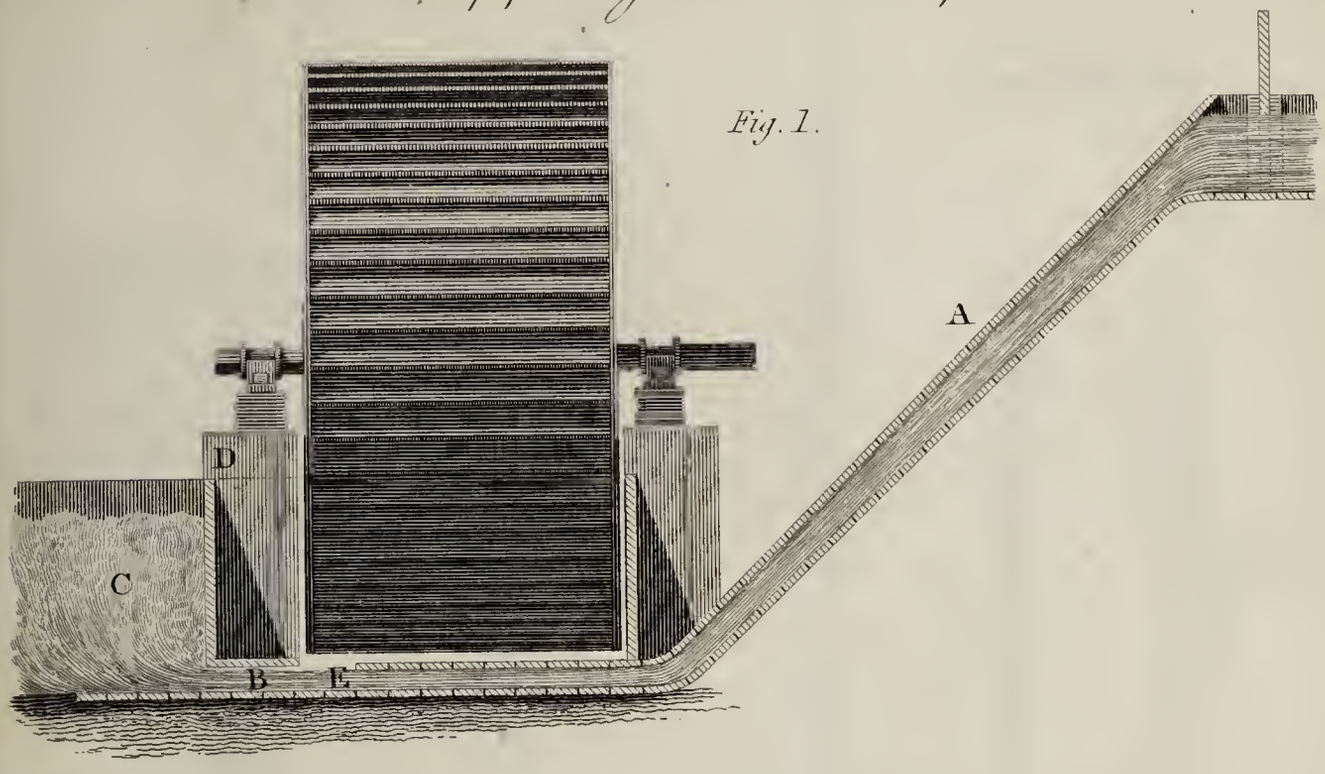


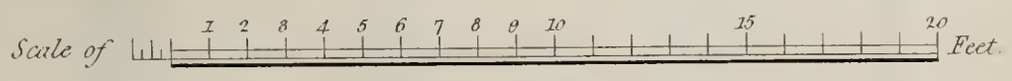
Drawn by J. Pinchback.

Engraved by J.B. Taylor.

Mr. J. Perkins's method of freeing water-wheels from back-water.

Fig. 1.





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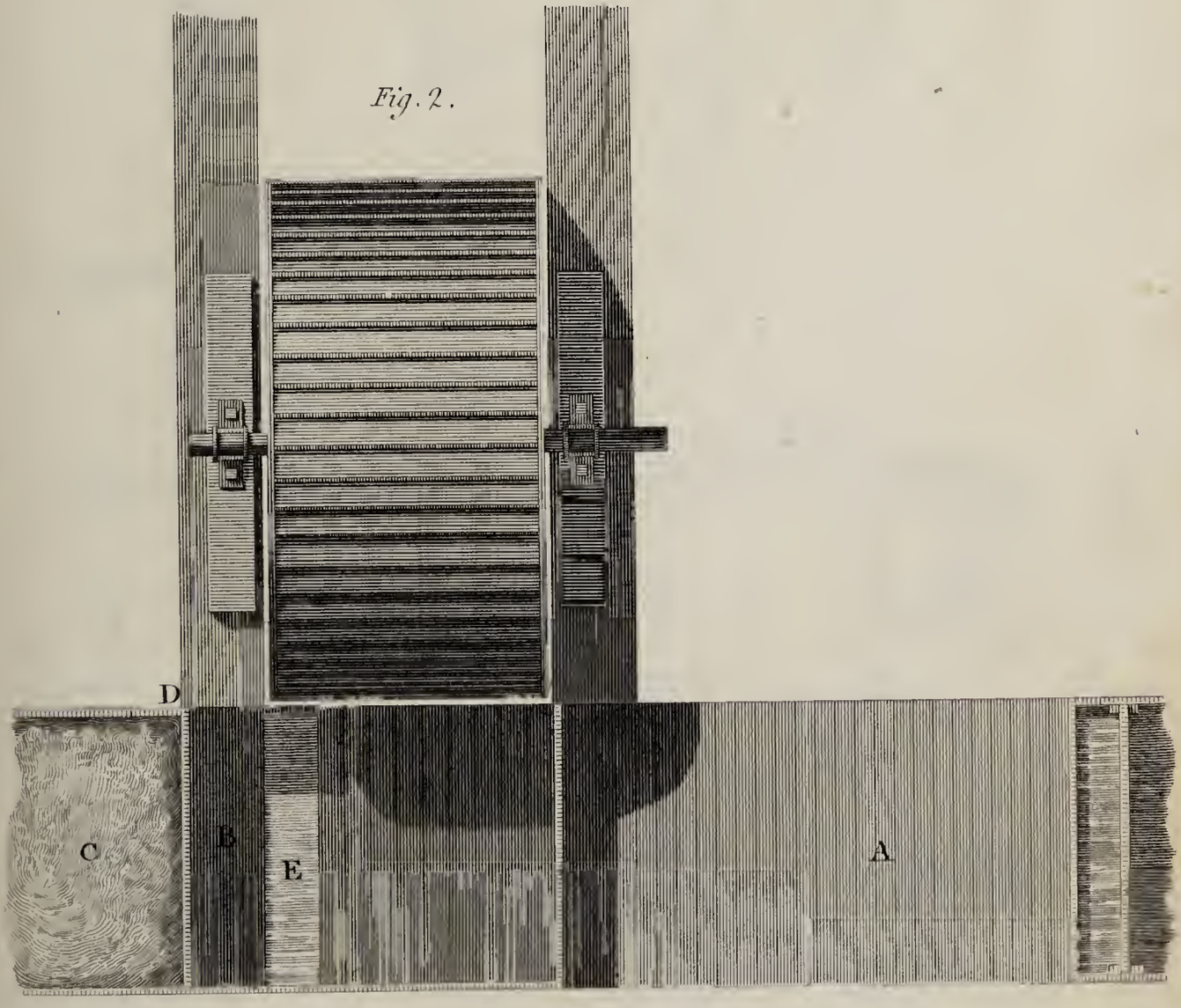


Drawn by J. Pinchback.

Engraved by J.B. Taylor.

Capt.n G. F. Stacks's Apparatus for those who have lost an Arm.

Fig. 1.

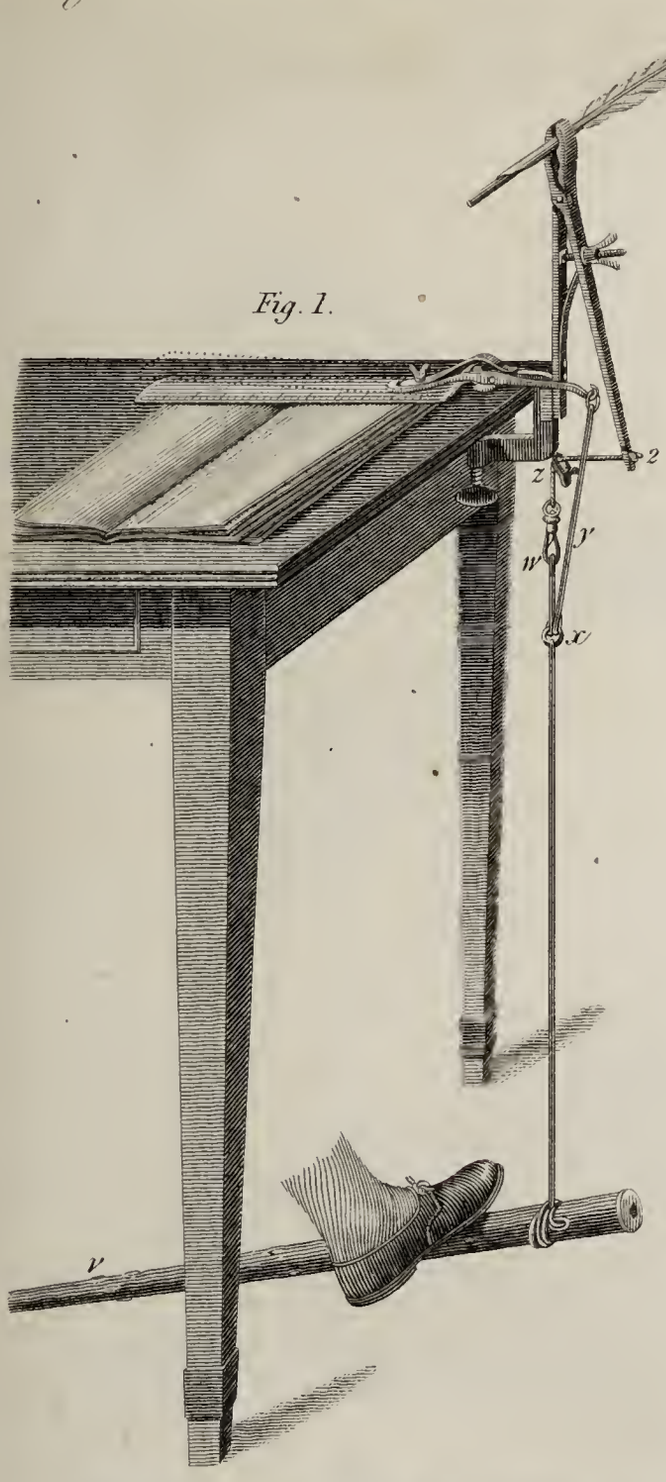


Fig. 9.

Fig. 8.

Fig. 6.

Fig. 7.

Fig. 4.

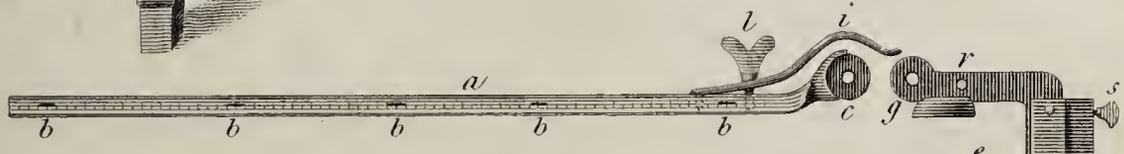
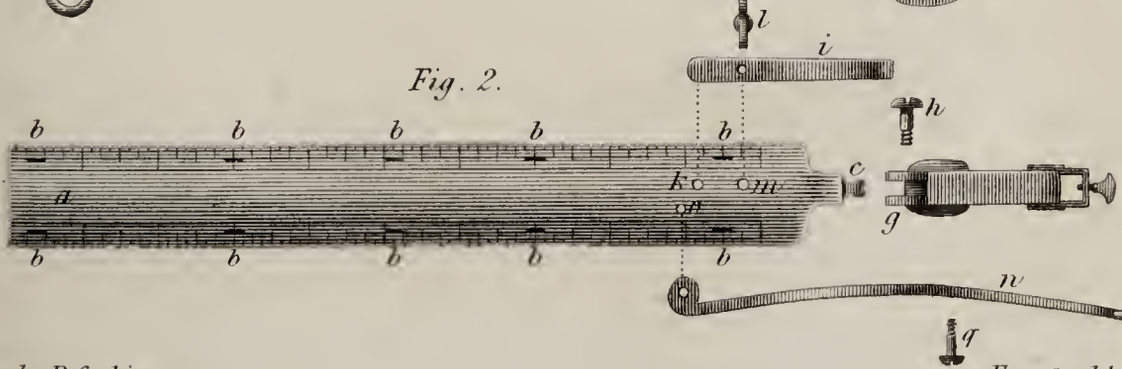



Fig. 3.

Fig. 5.

Fig. 2.



Drawn by R. Cocking.

Engraved by G. Gladwin.

W.m W.m Hookey's Improved Boat Rudder

Fig. 1.

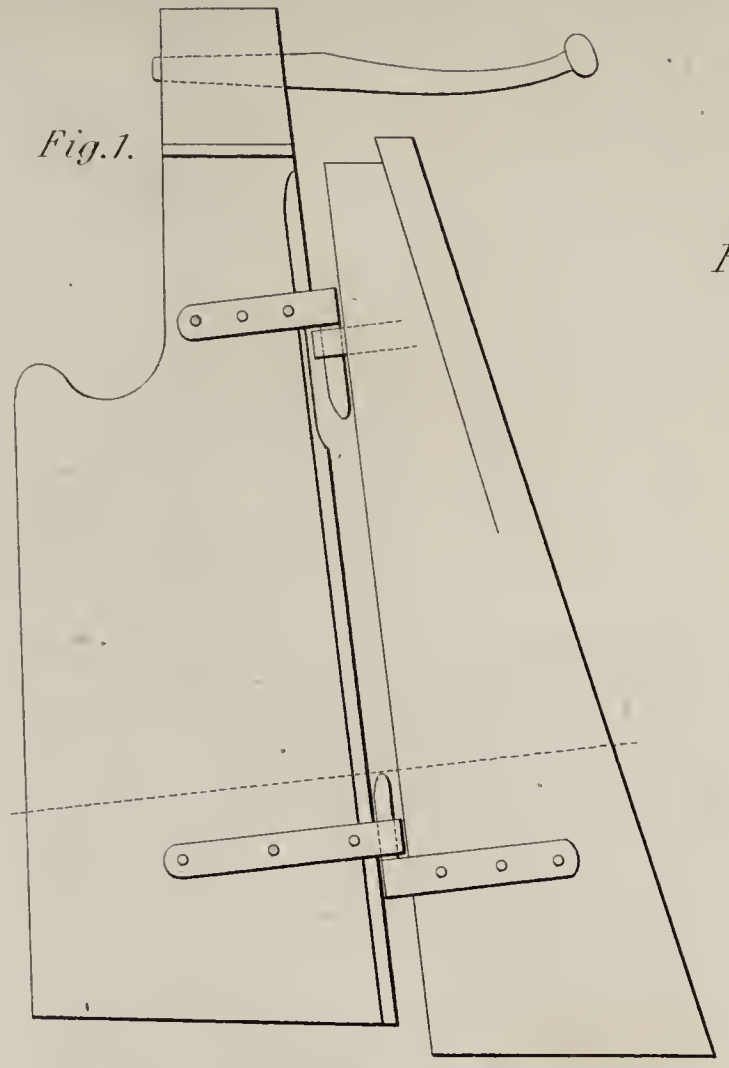
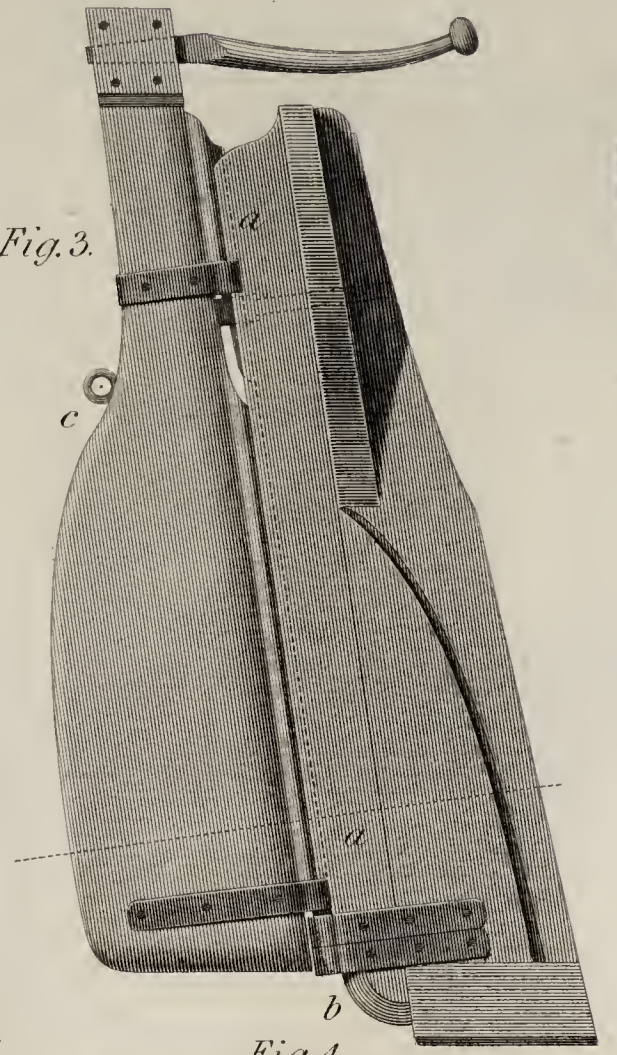


Fig. 2.

Fig. 3.



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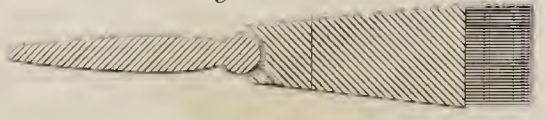

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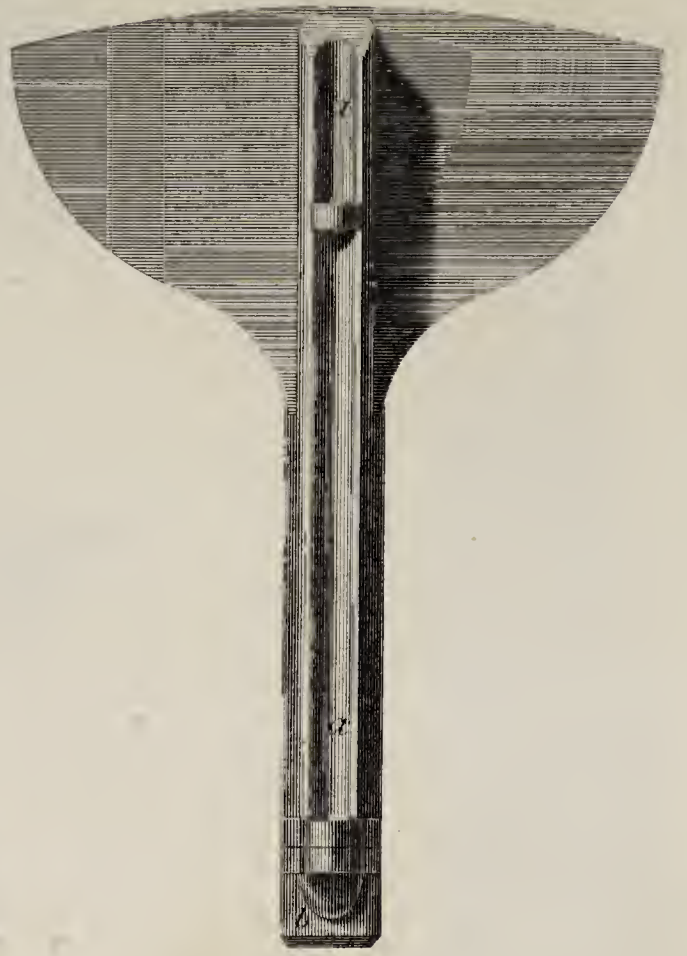


Fig. 6.

Drawn by Joseph Clement.

Engraved by James Davis.

Mr. Wm. Hookey's Improved Rudder, for Merchant Ships.

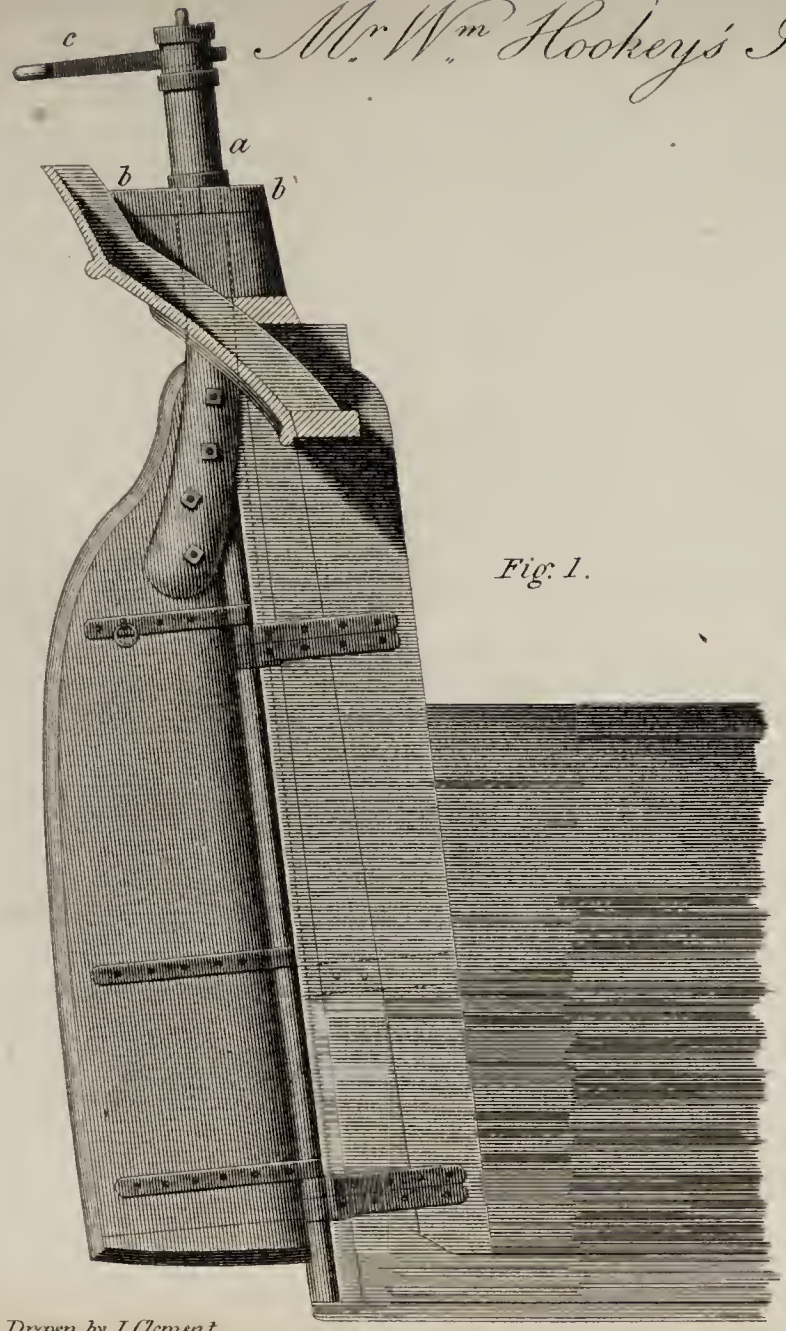
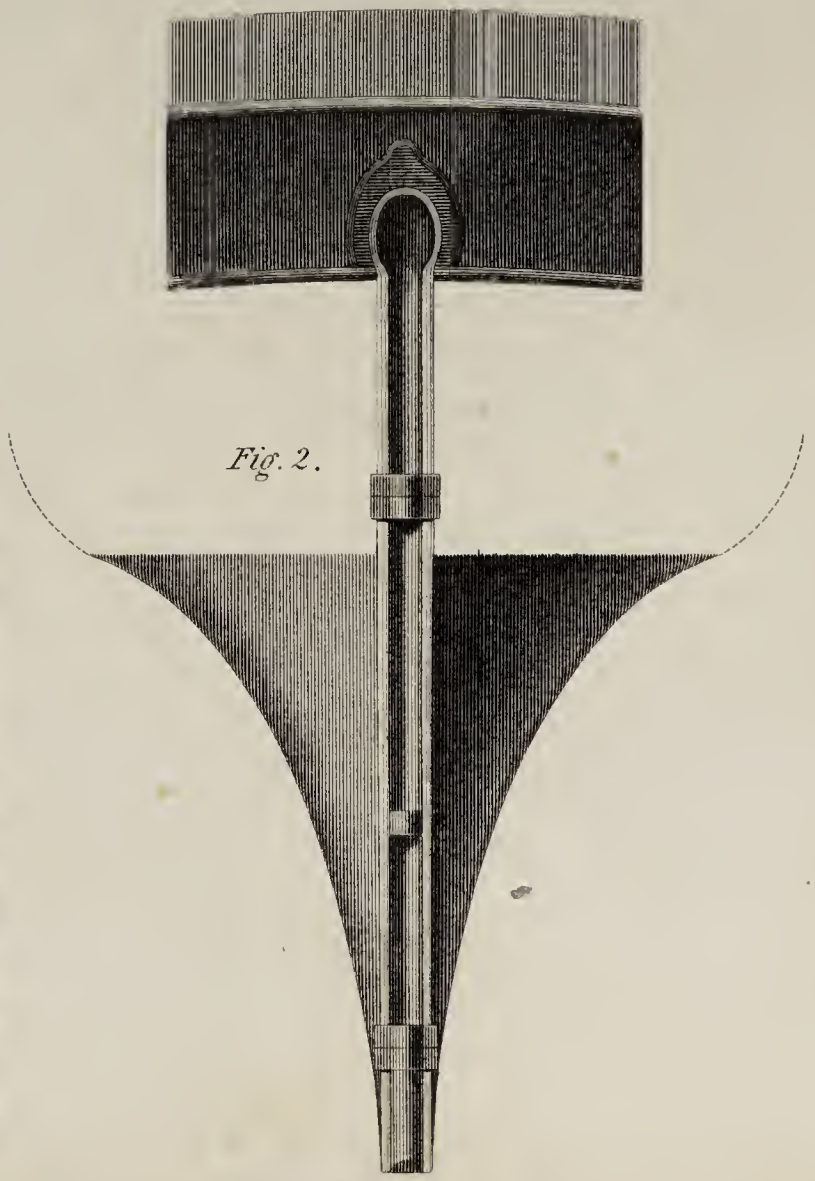


Fig. 1.



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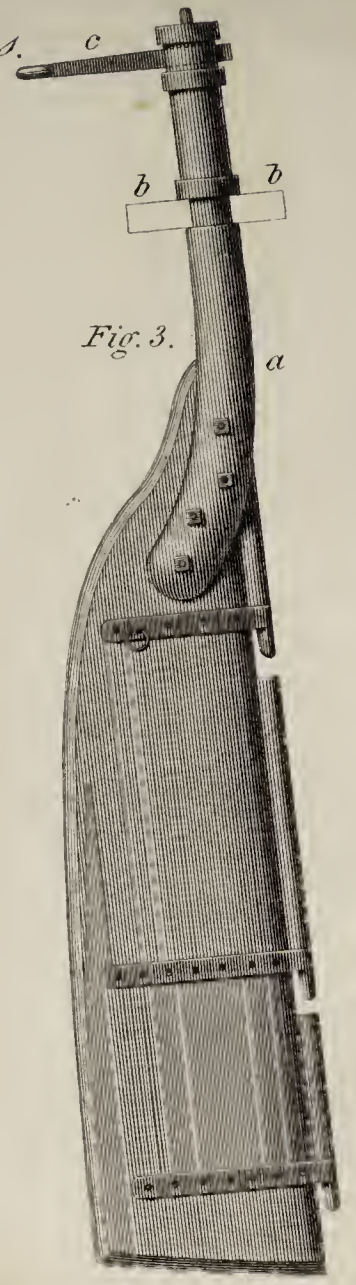


Fig. 3.

Fig. 4.

Drawn by J. Clement.

Engraved by James Davis.

Mr. Wm. Hookey's Improved Rudder for a Ship of 1600 Tons.

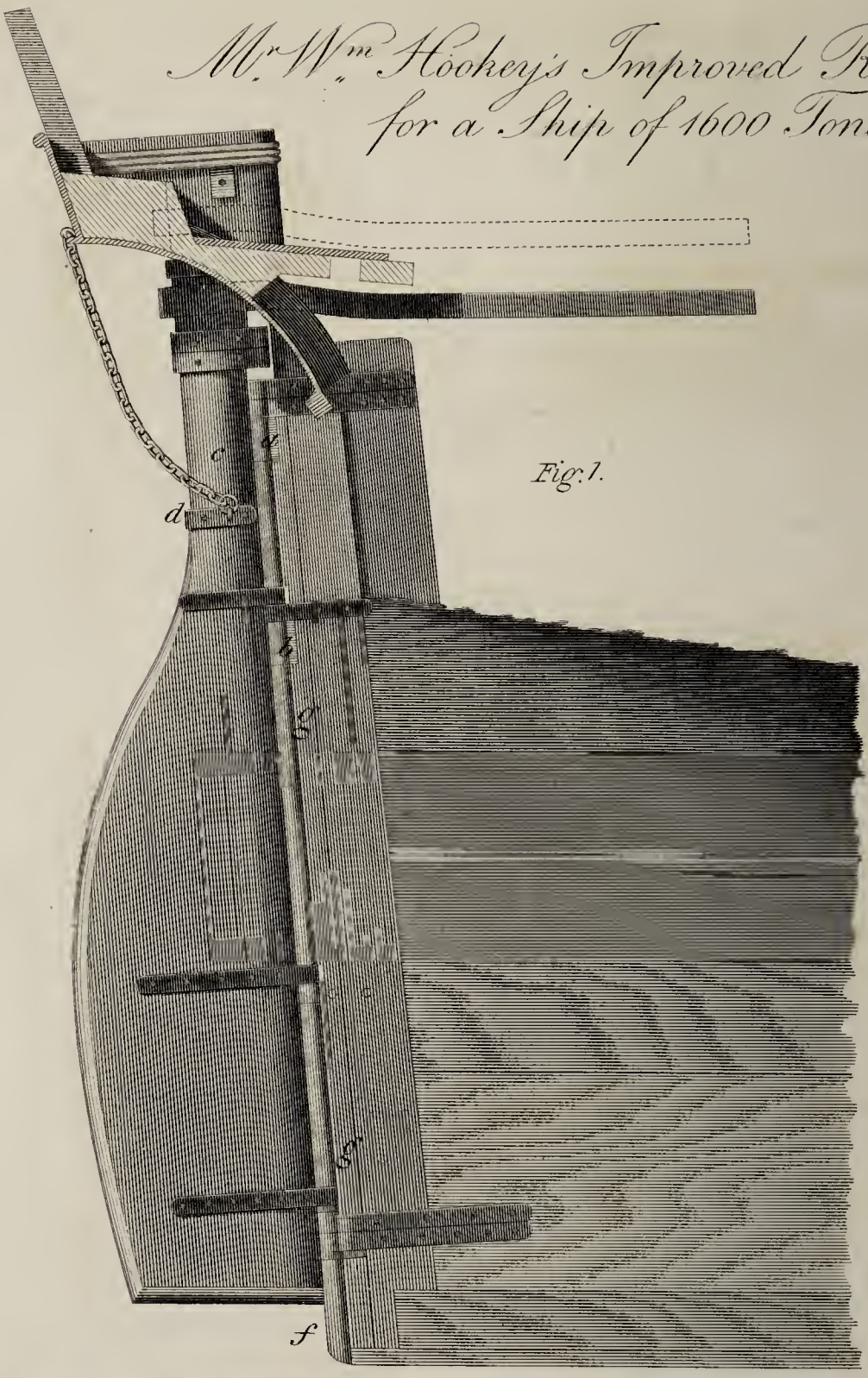


Fig. 1.

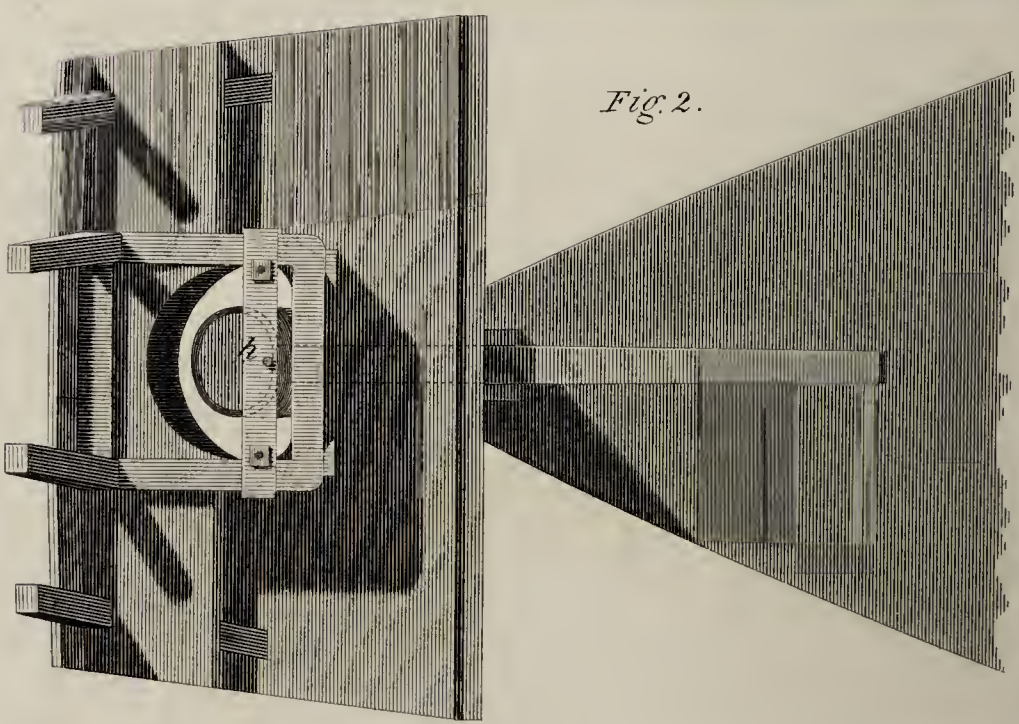


Fig. 2.

Feet

Drawn by Joseph Clement.

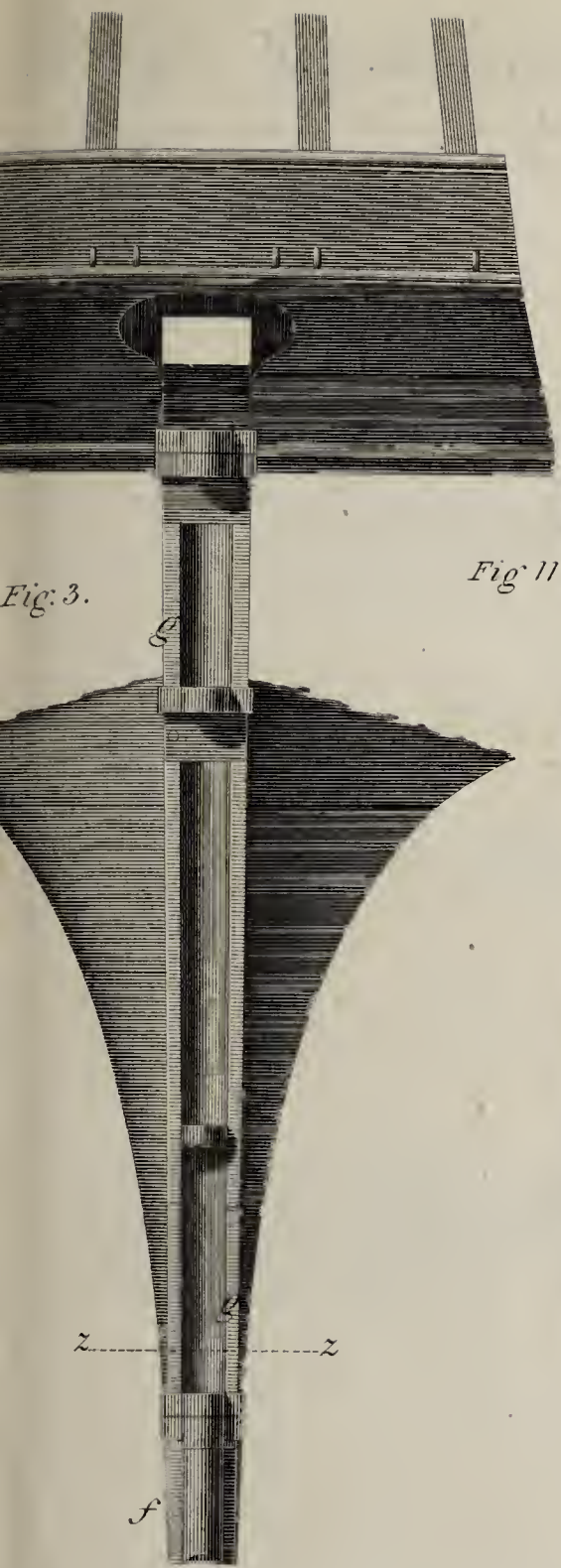


Fig. 3.

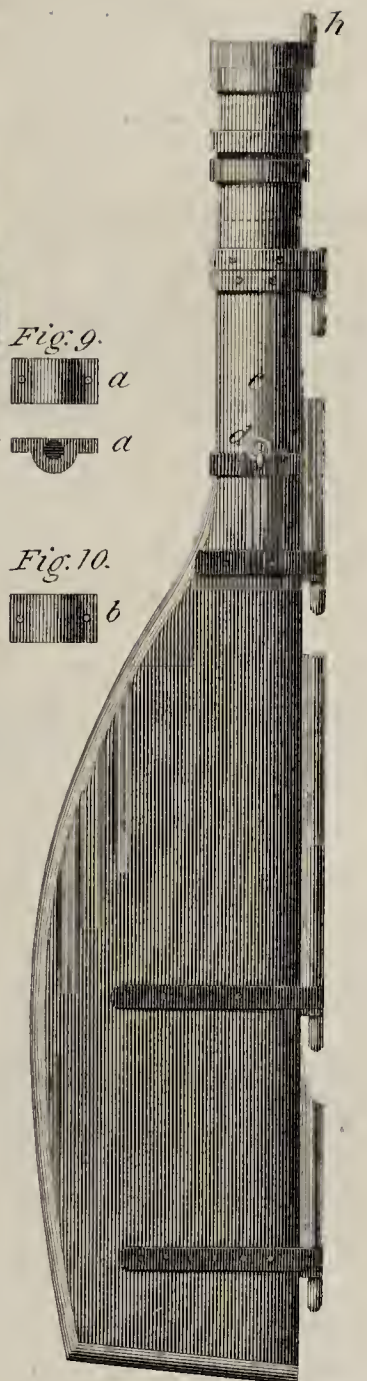


Fig. 5.

Fig. 6.

Fig. 9.

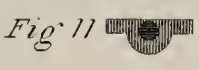


Fig. 11

Fig. 10.

Fig. 4.

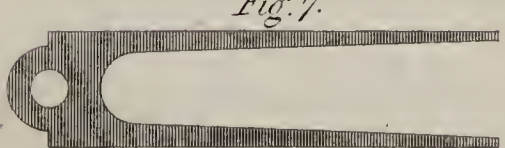
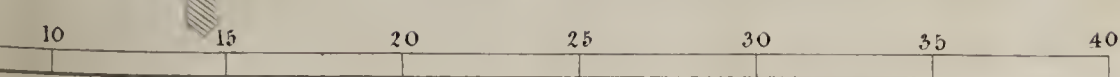


Fig. 7.

Fig. 8.



Engraved by James Davis.

Mr. Wm. Hookey's Temporary Ship's Rudders.

Fig. 3.

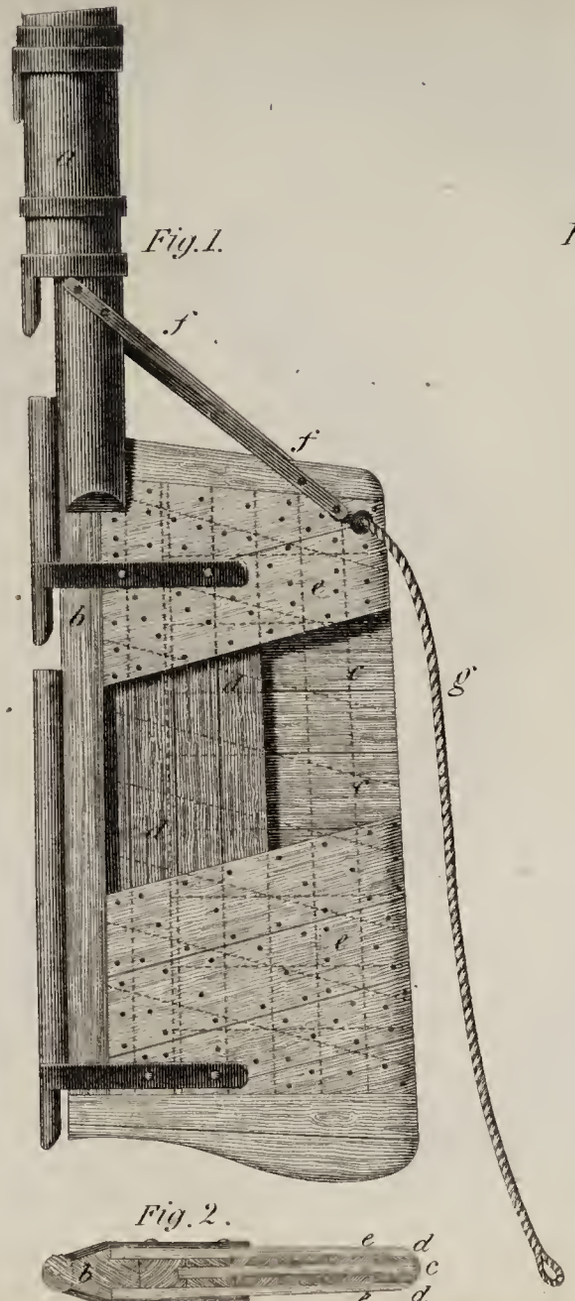


Fig. 1.

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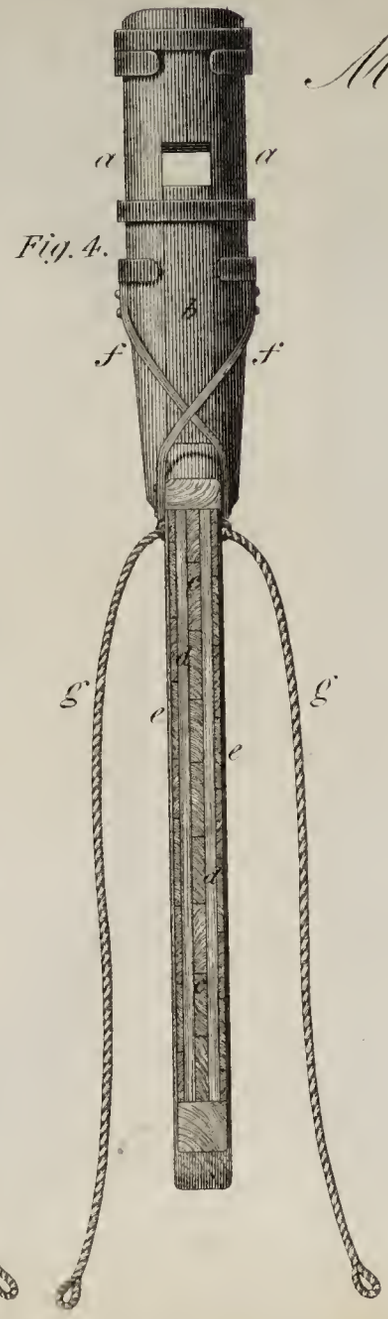

Fig. 4.

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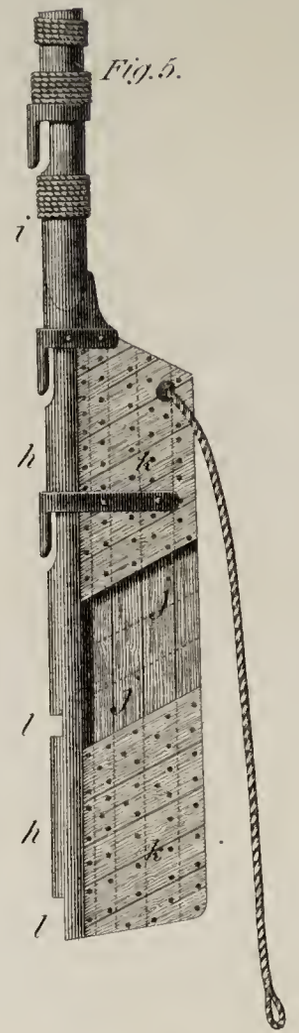

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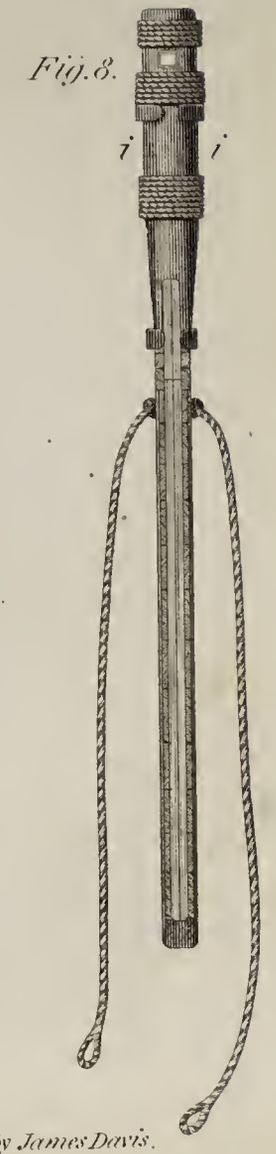


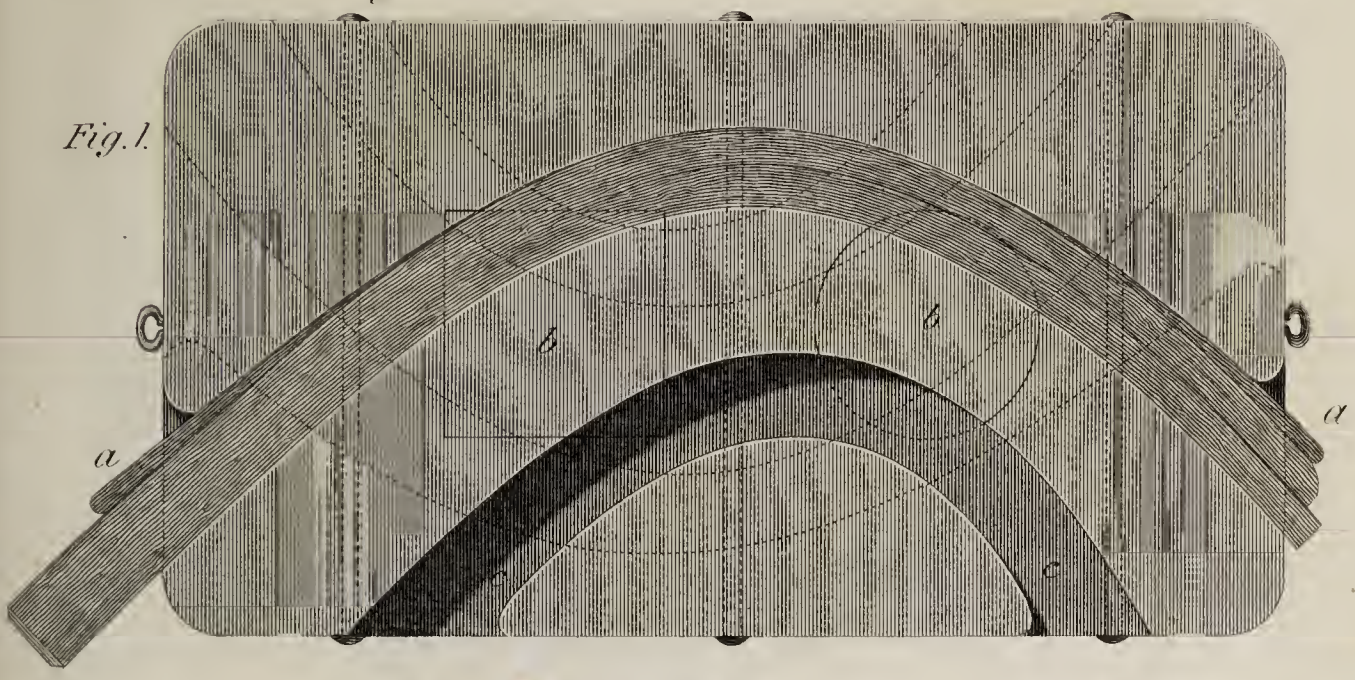
Fig. 8.

Drawn by Joseph Clement.

Engraved by James Davis.

Mr. Wm. Hookey's Improved Boats Knees and Timbers.

Fig. 1.



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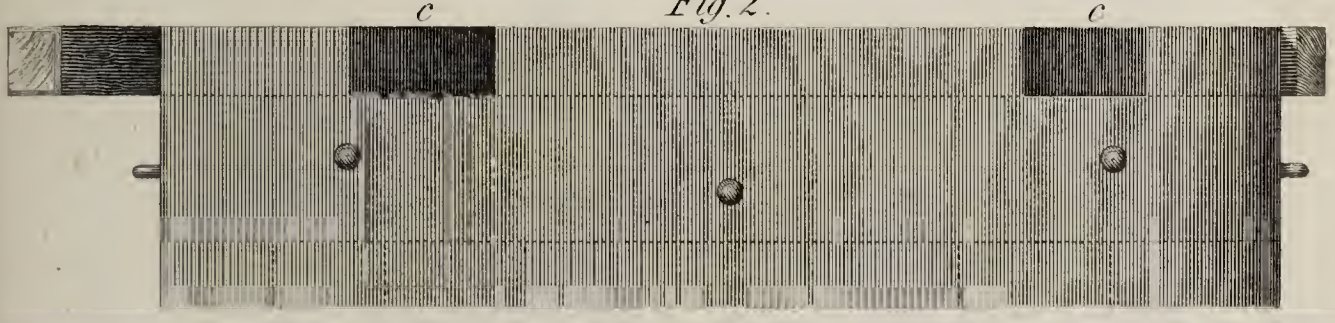

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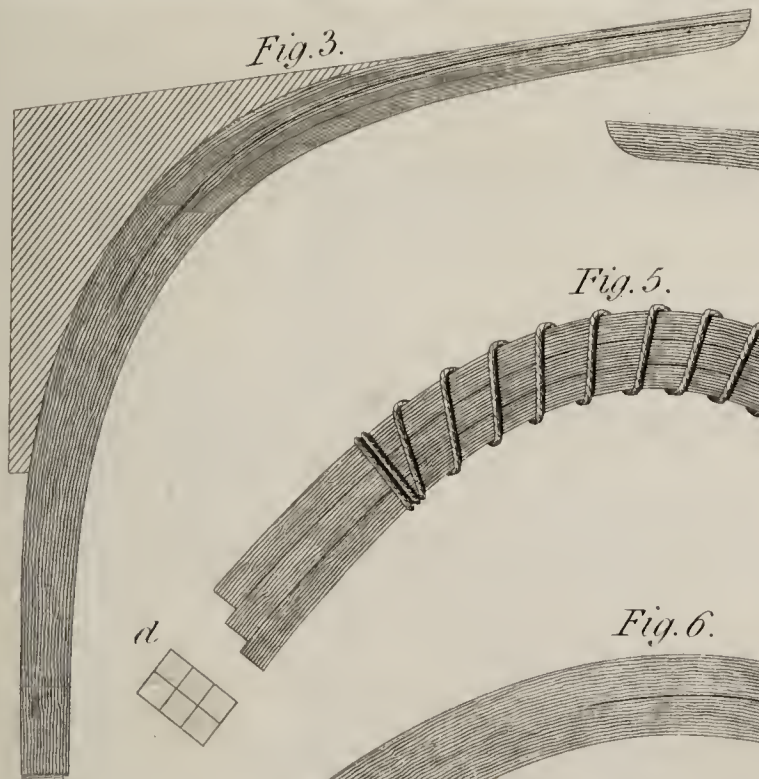

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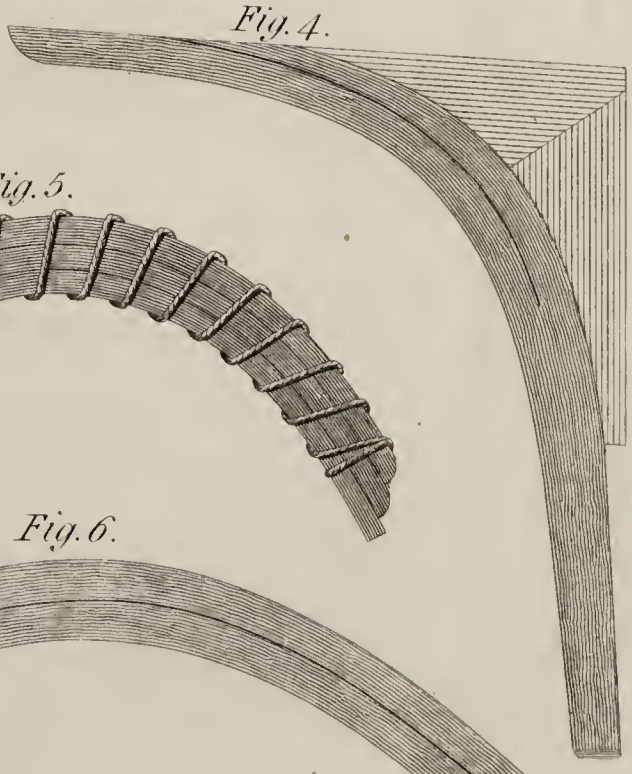

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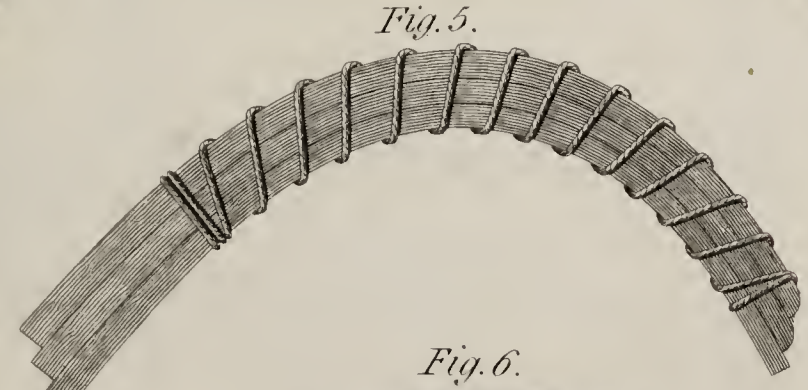

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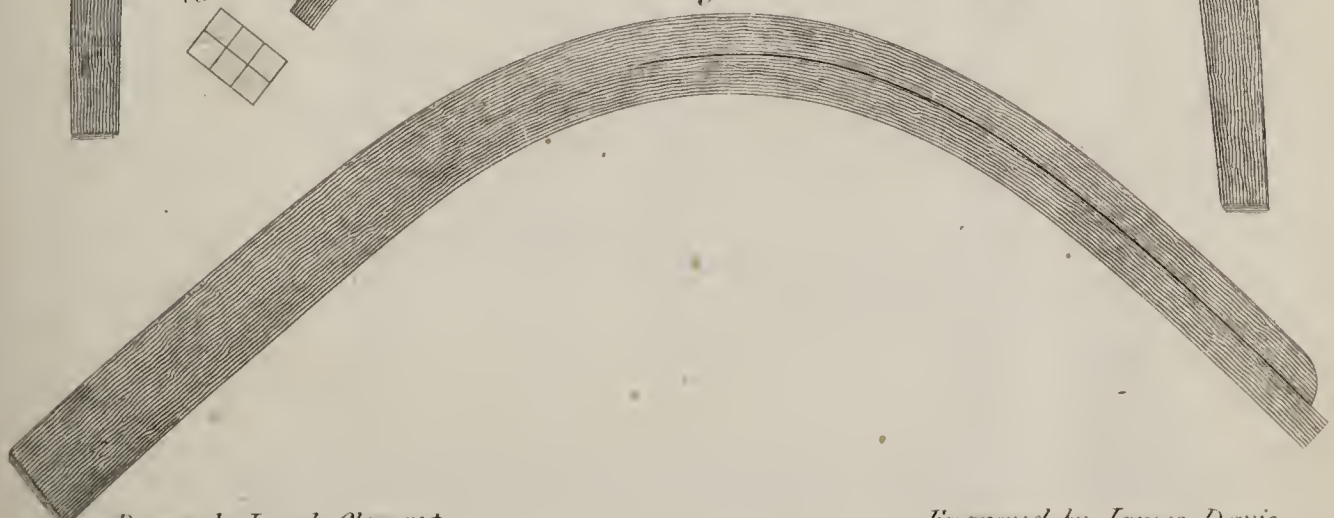


Drawn by Joseph Clement.

Engraved by James Davis.

Mr Wm Hookey's Chain Beams.

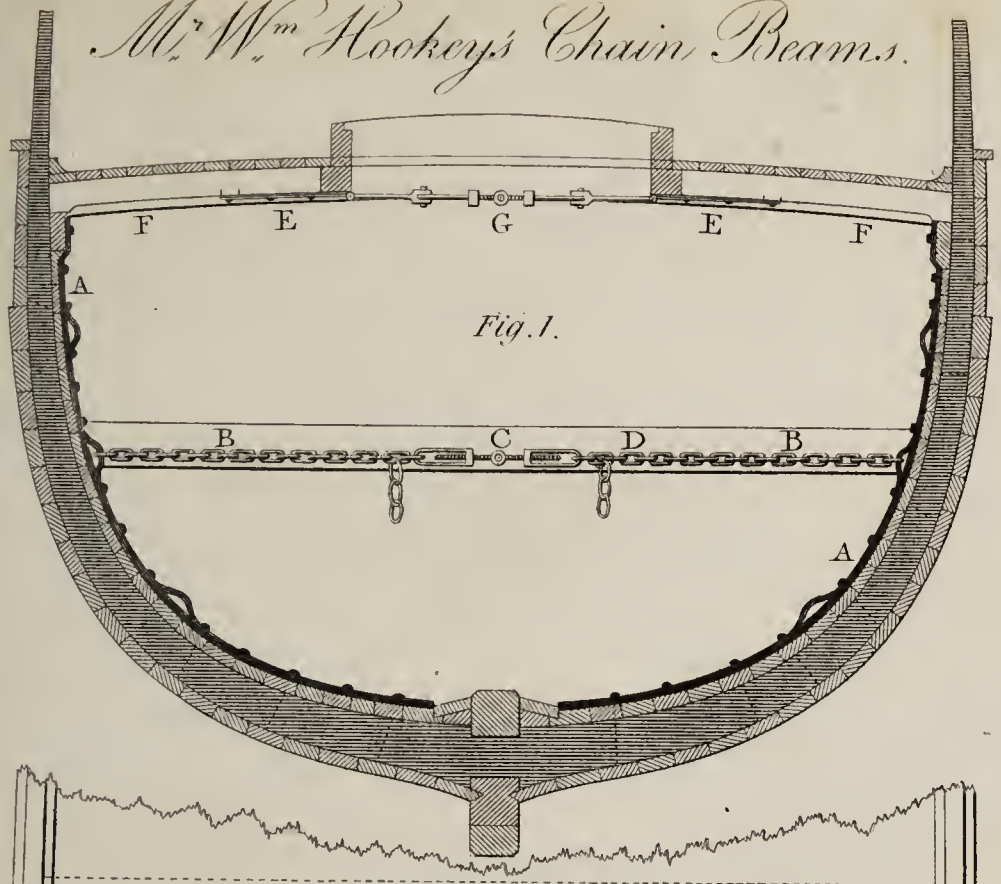
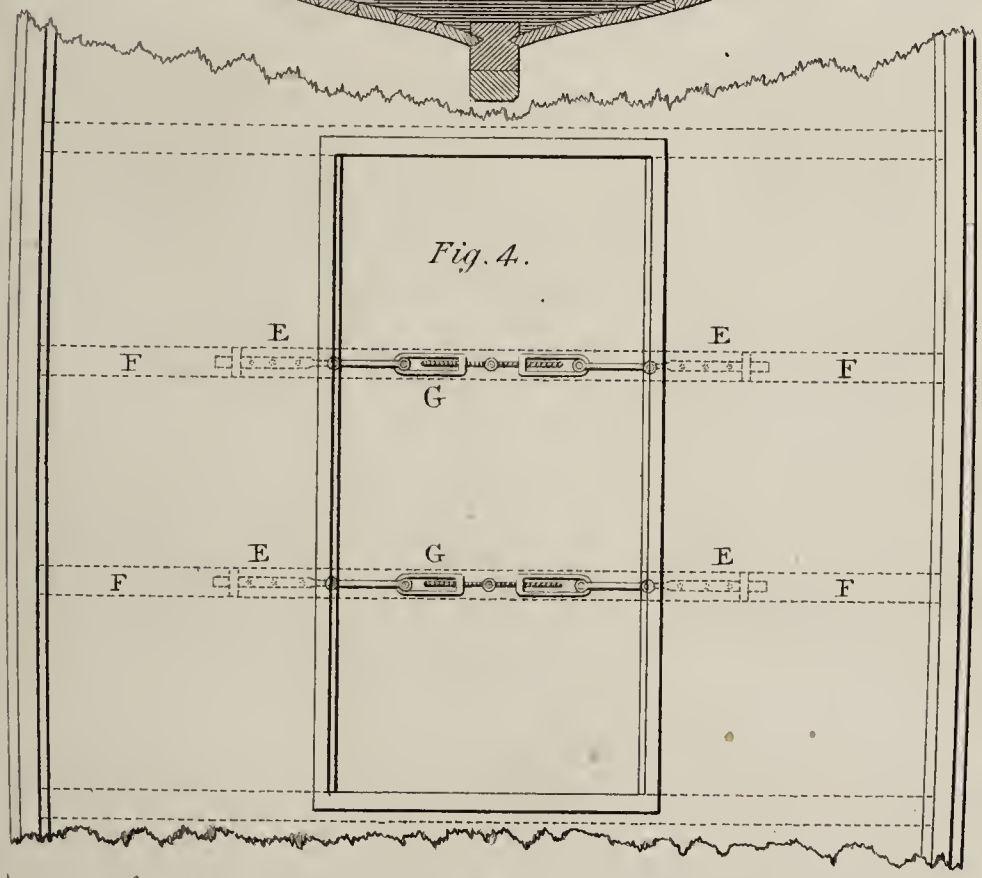


Fig. 1.



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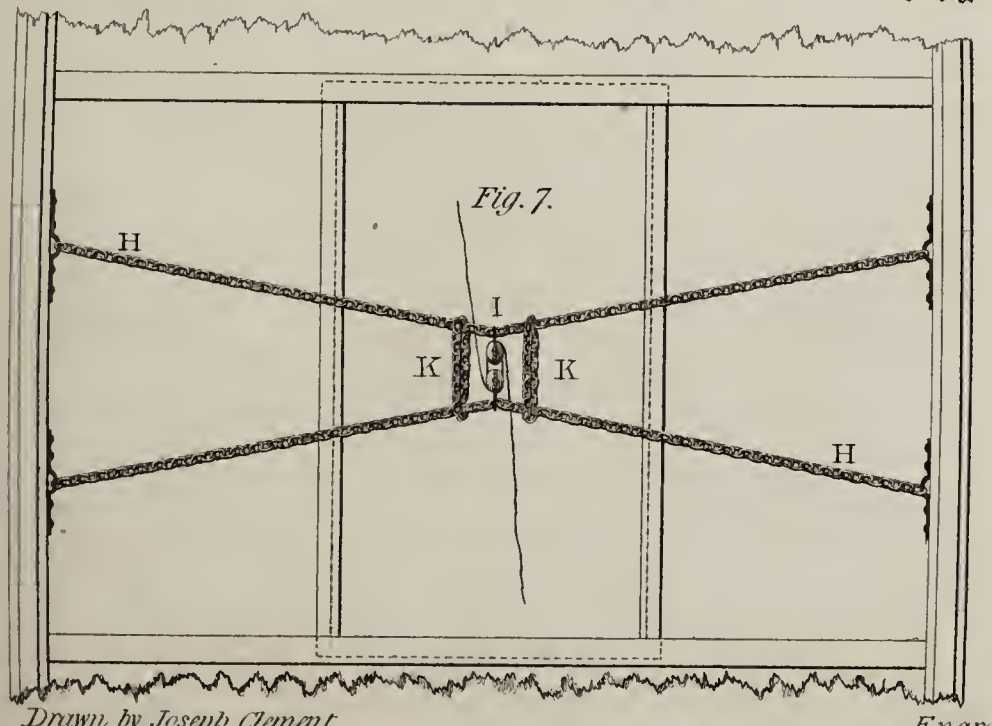


Fig. 7.

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 6.

Drawn by Joseph Clement.

Engraved by James Davis.

Method of Propelling Ships.

by Capt. James Burton.

Fig. 2.

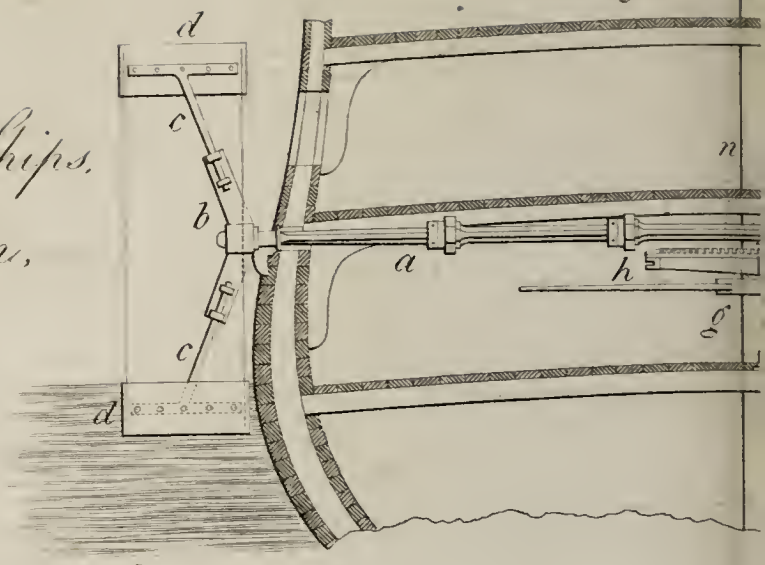
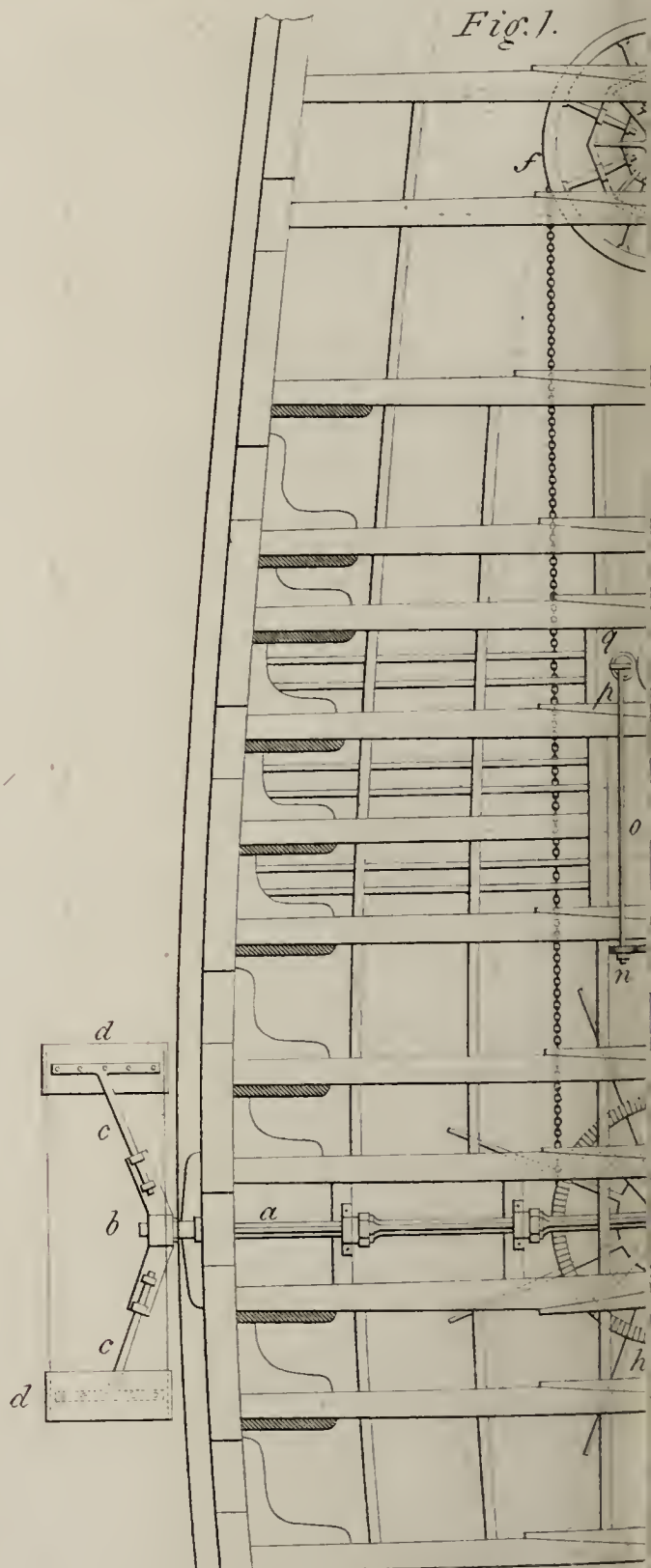


Fig. 1.



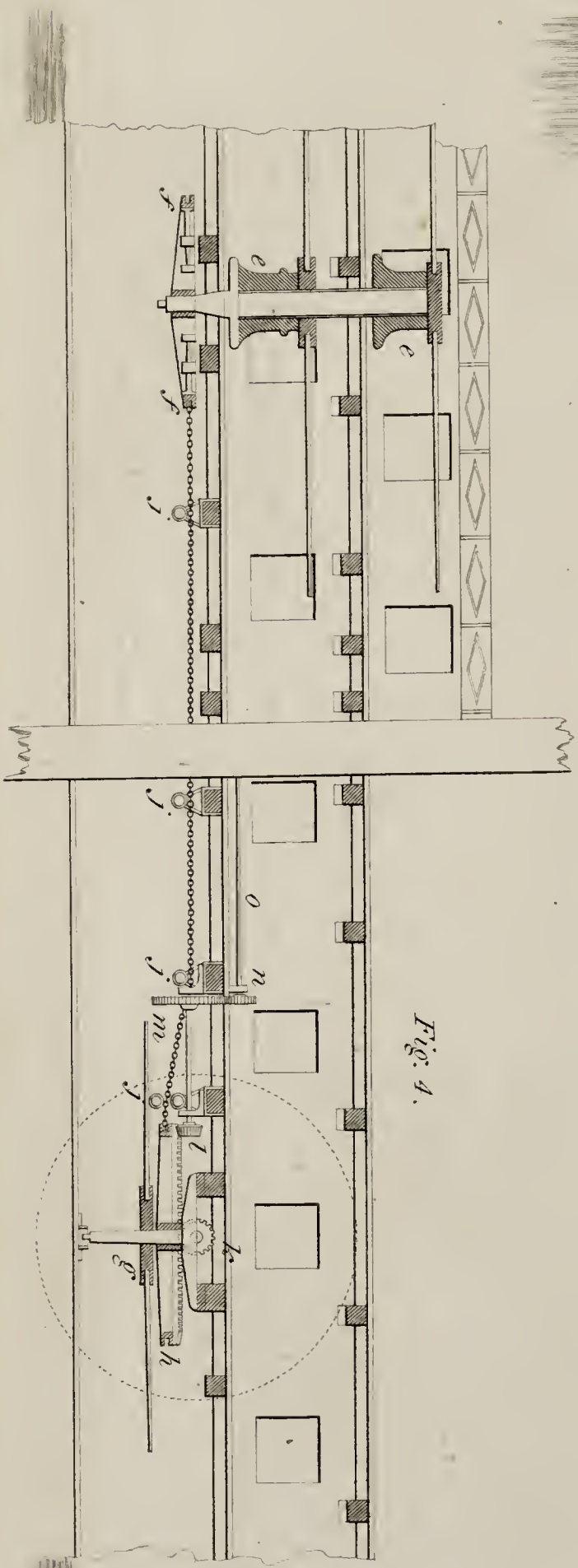
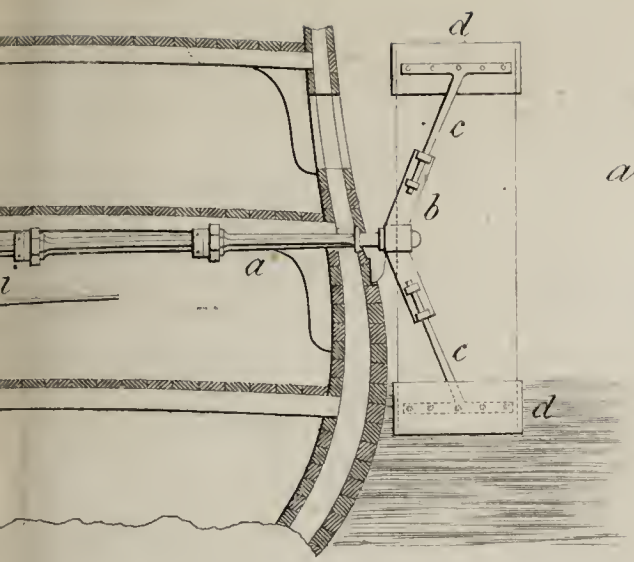
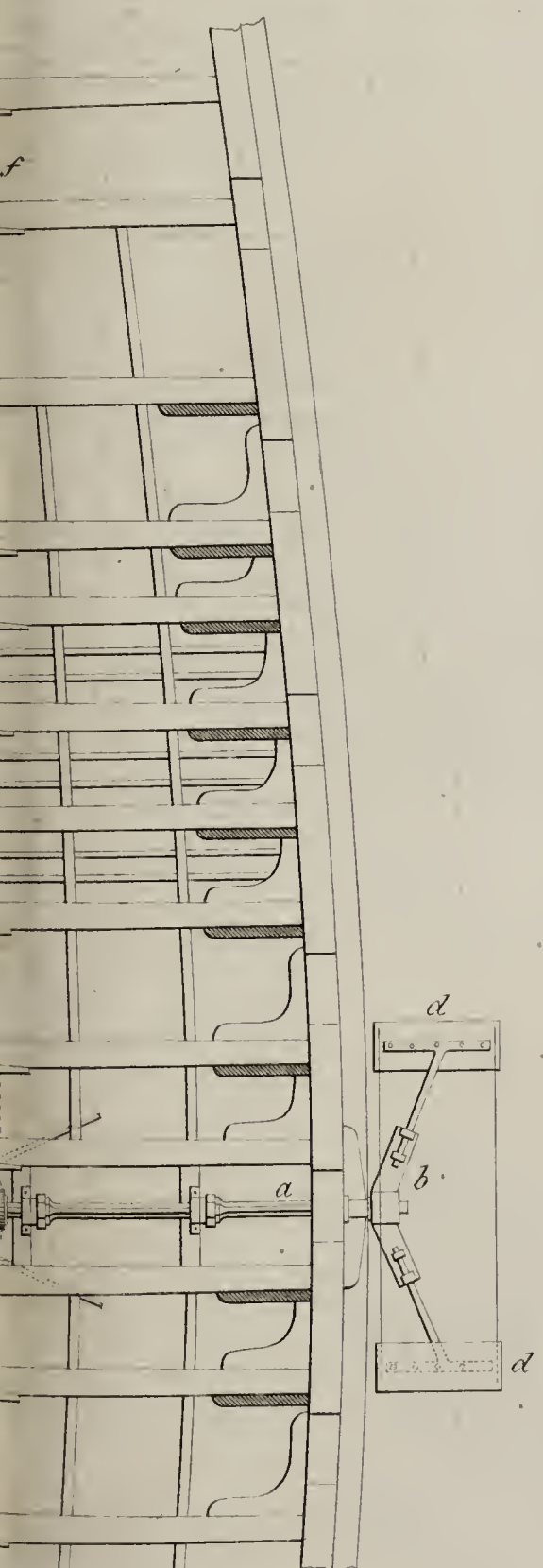


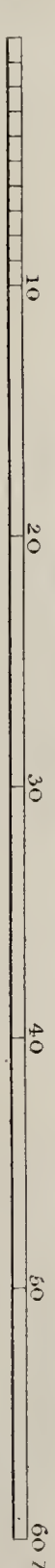
Fig. 4.

Drawn by Joseph Clement.

and Working the Pumps of the Royal Navy.







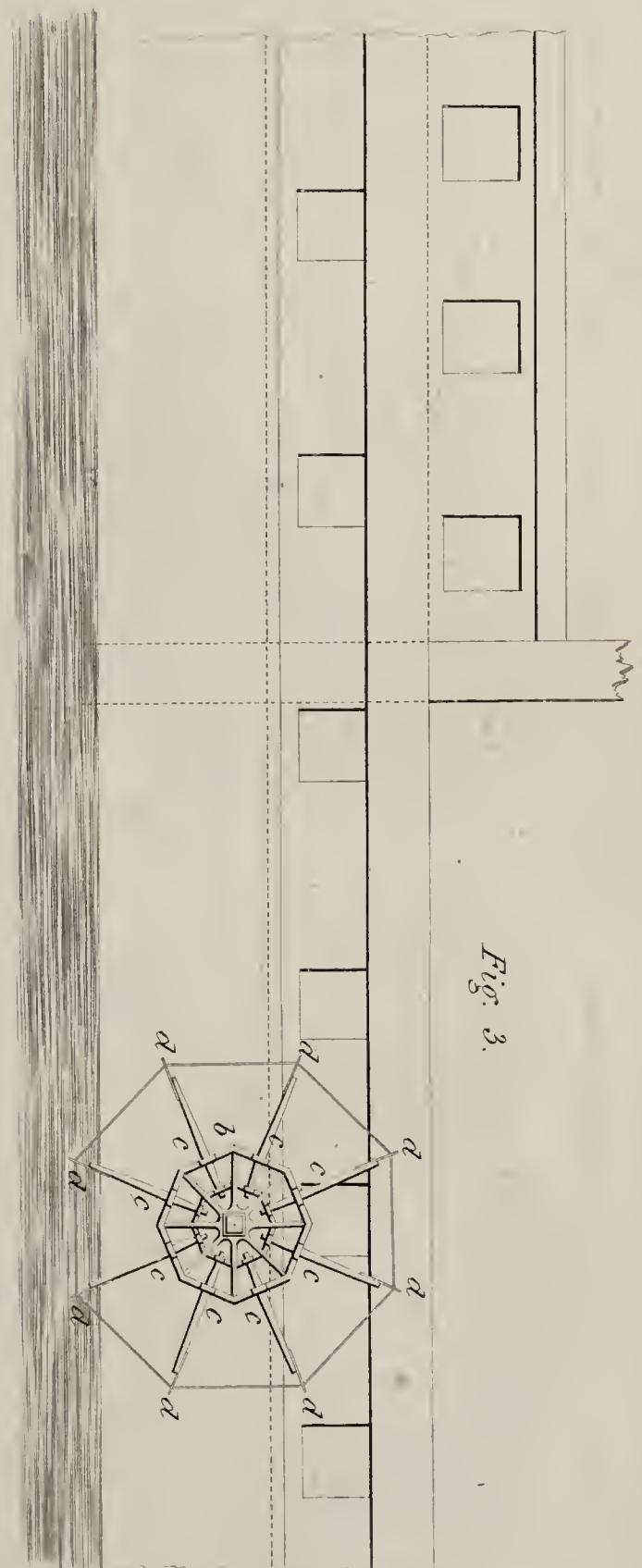


Fig. 3.

Engraved by James Davis.

Mr. O Elliot's Safe Coach.

Fig. 1.

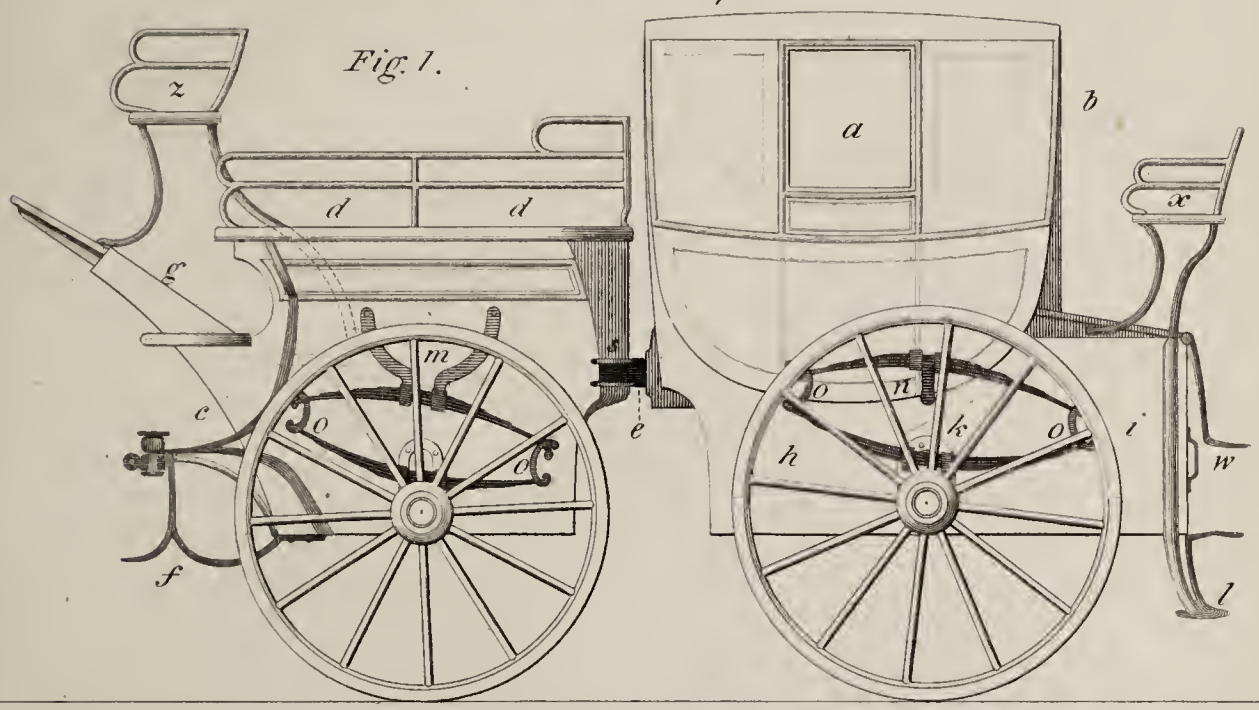


Fig. 2

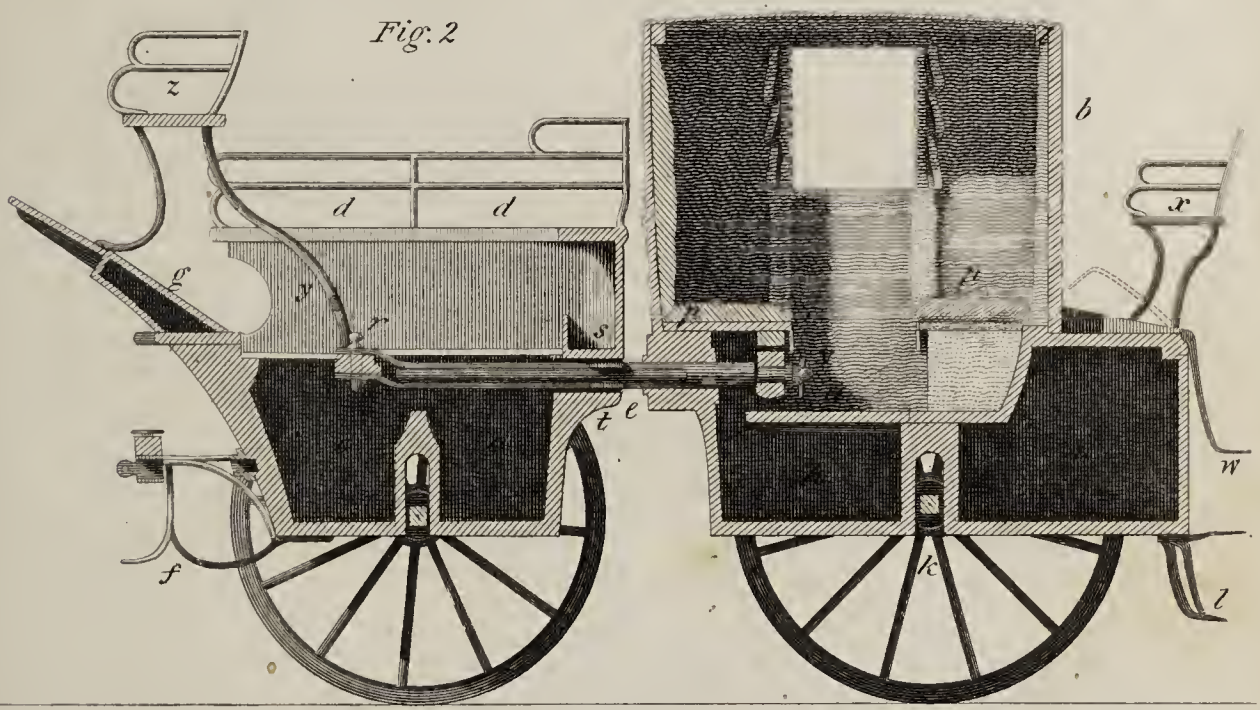
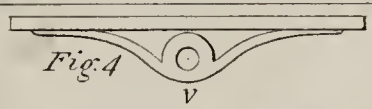


Fig. 4



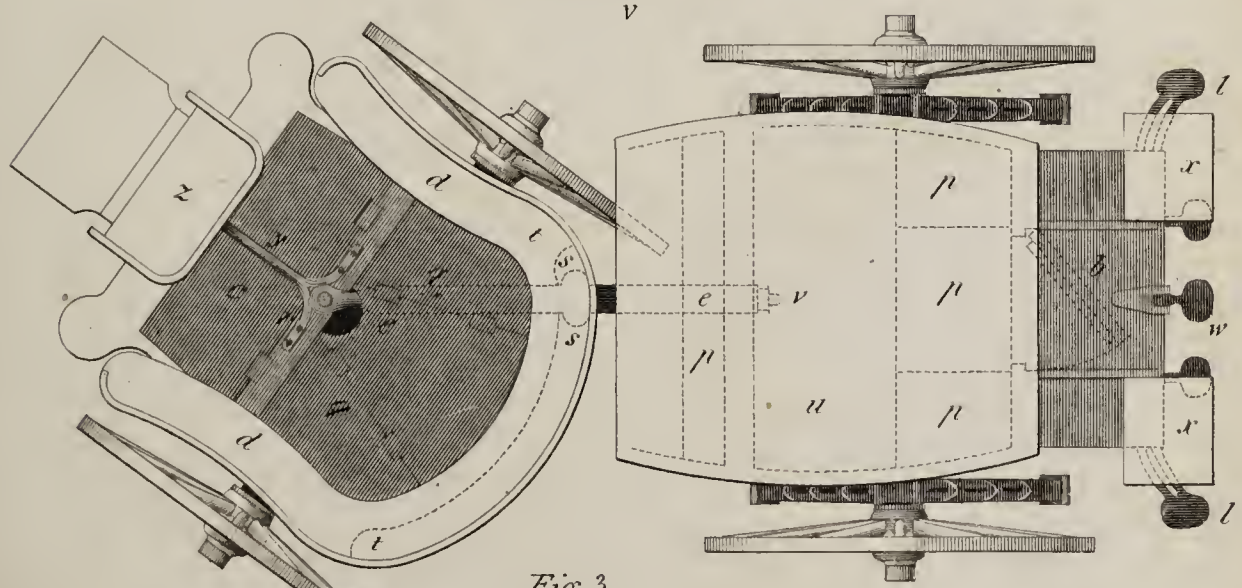
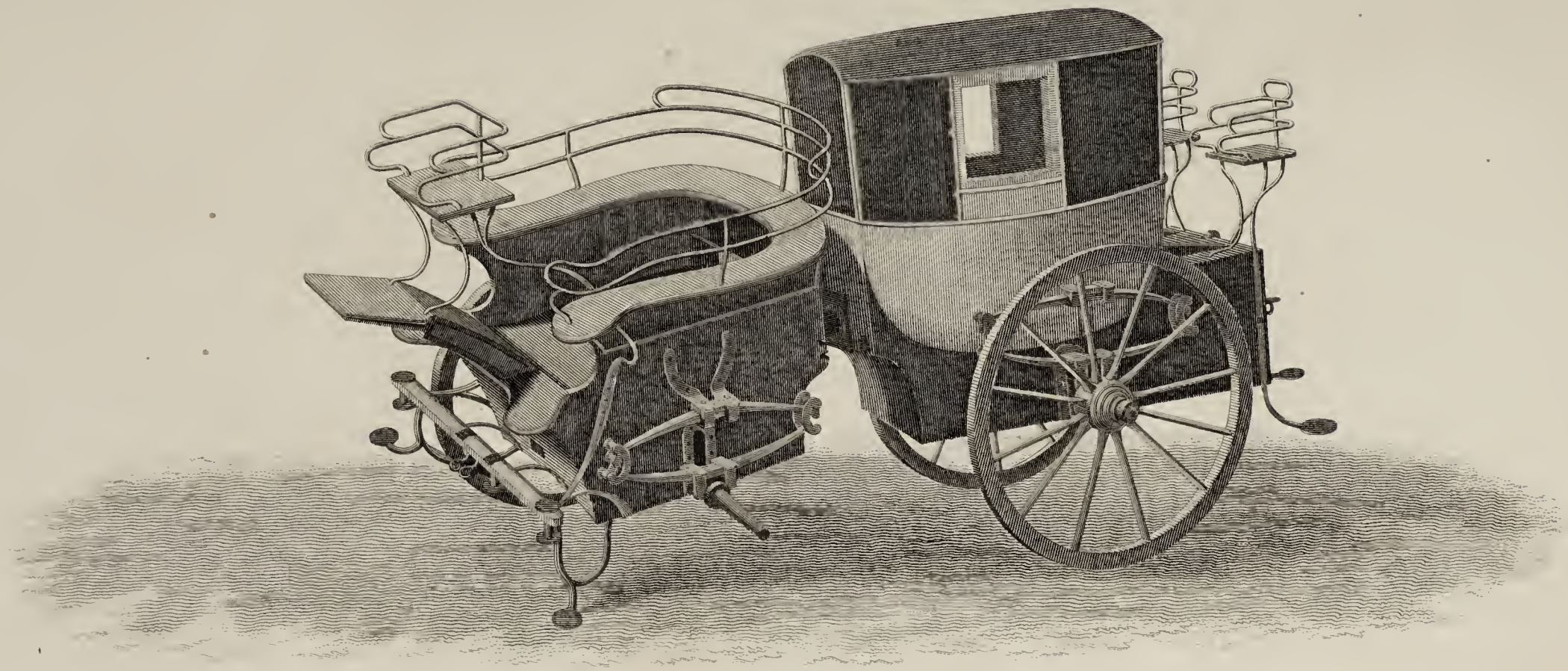


Fig. 3.

Drawn by Cornelius Varley.

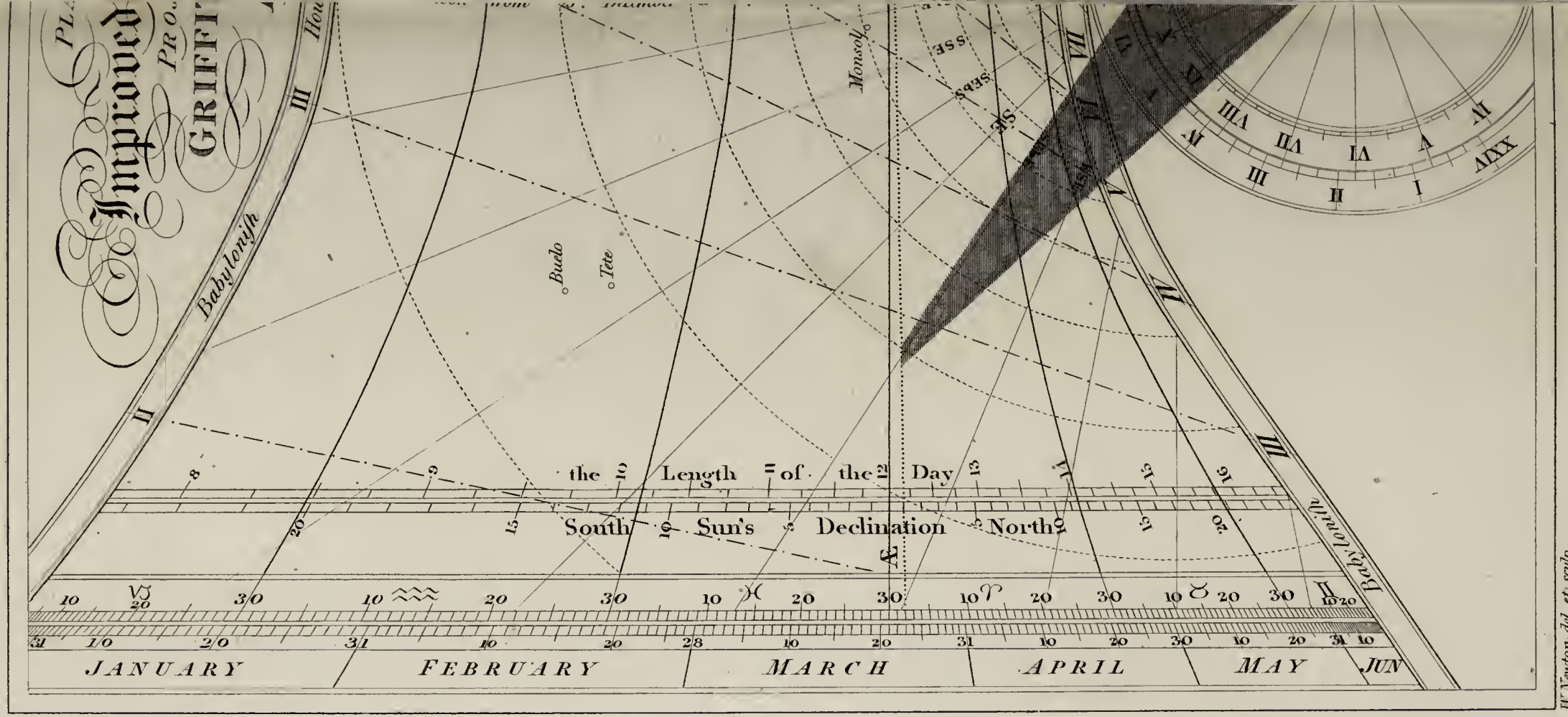
Engraved by James Davis.

Mr. O'Elliots Safe Coach.



Drawn by Cornelius Varley.

Engraved by James Davis.


Improved
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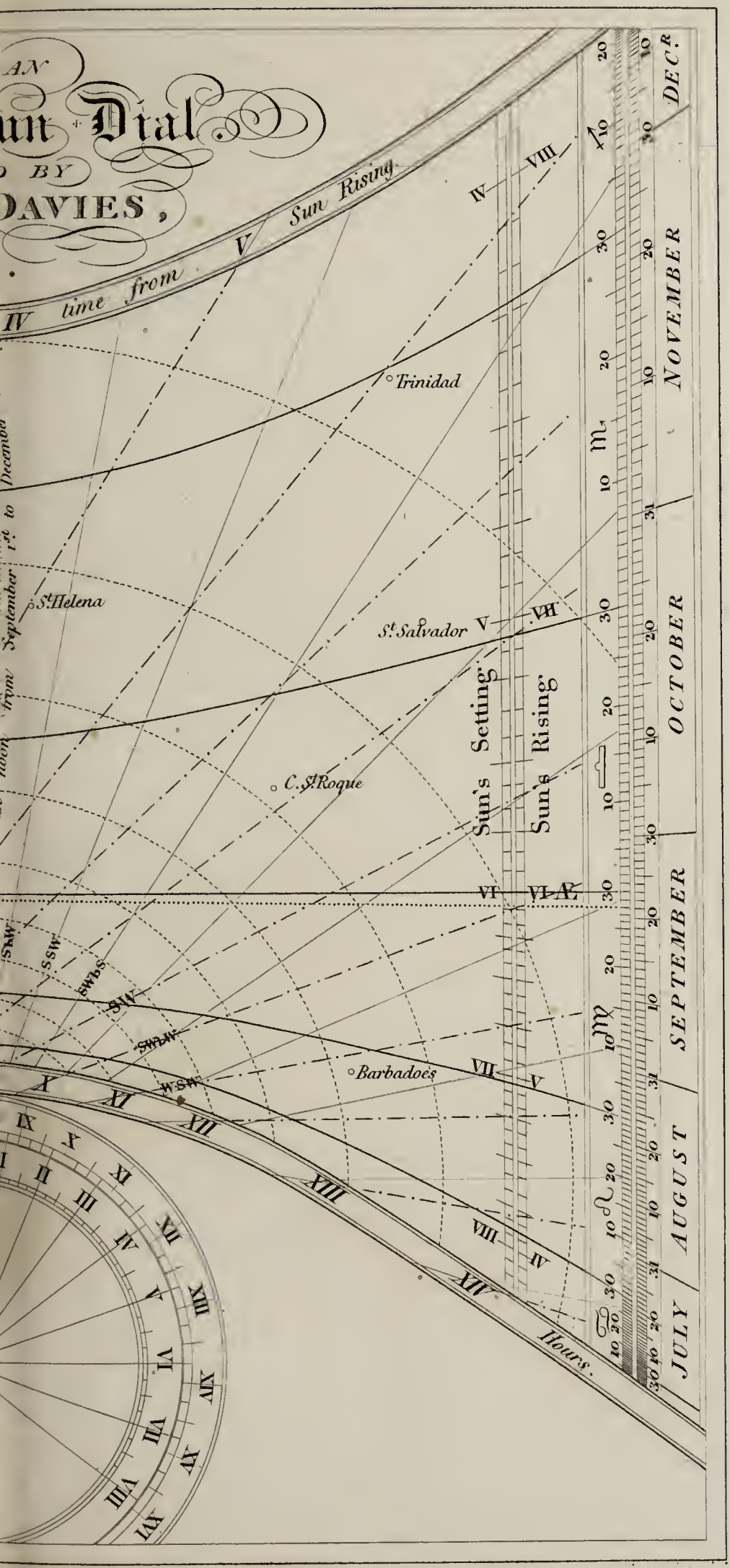
Babylonish
Babylonian
Buelo
Tete
Monsoon
SSE
SEbS
SE
the Length of the Day
South Sun's Declination North
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUN
W.Newton del. et sculp.


AN
un Dial
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IV time from V Sun Rising
Trinidad
St Helena
St Salvador
C. St Roque
Barbadoes
Sun's Setting
Sun's Rising
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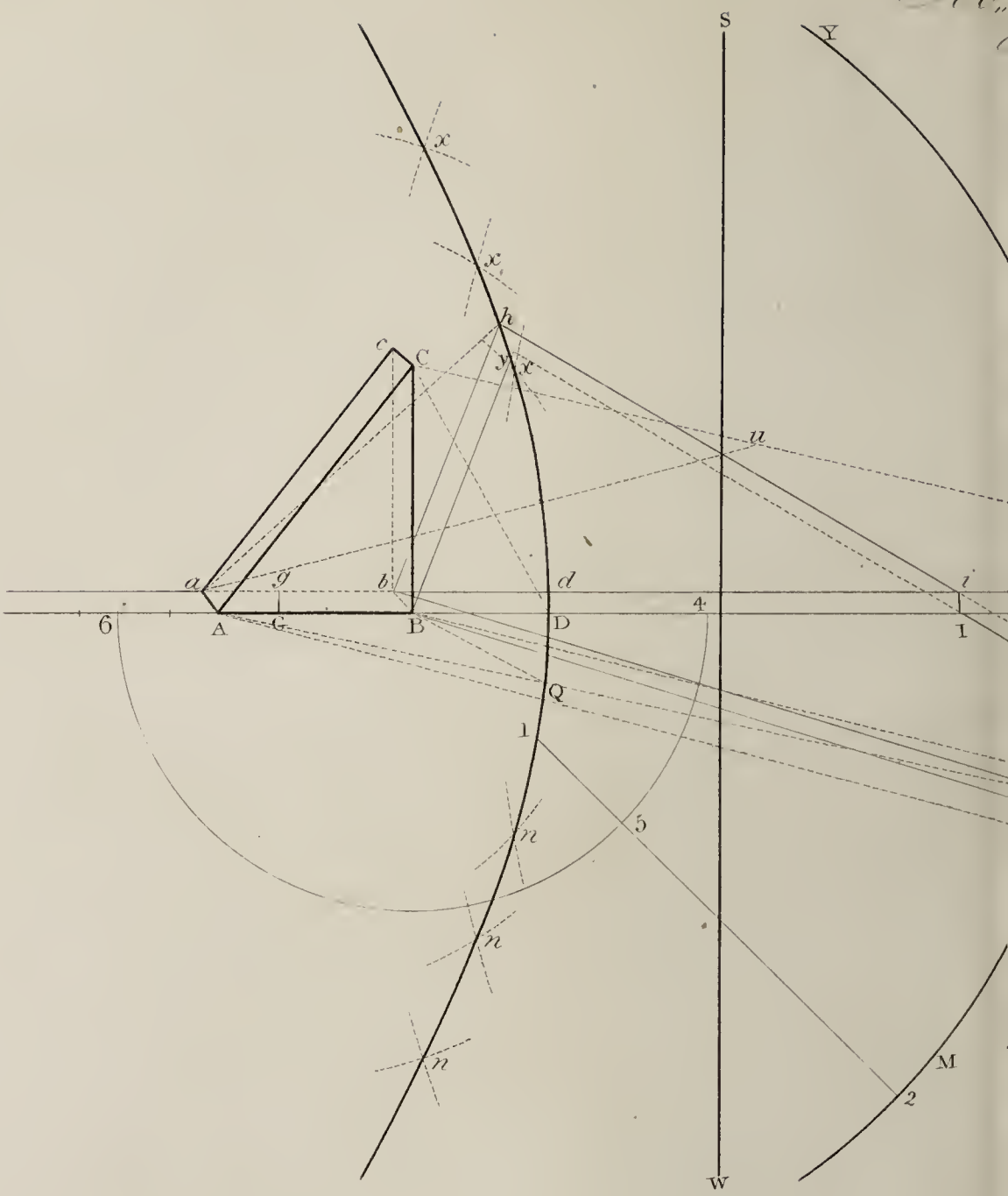
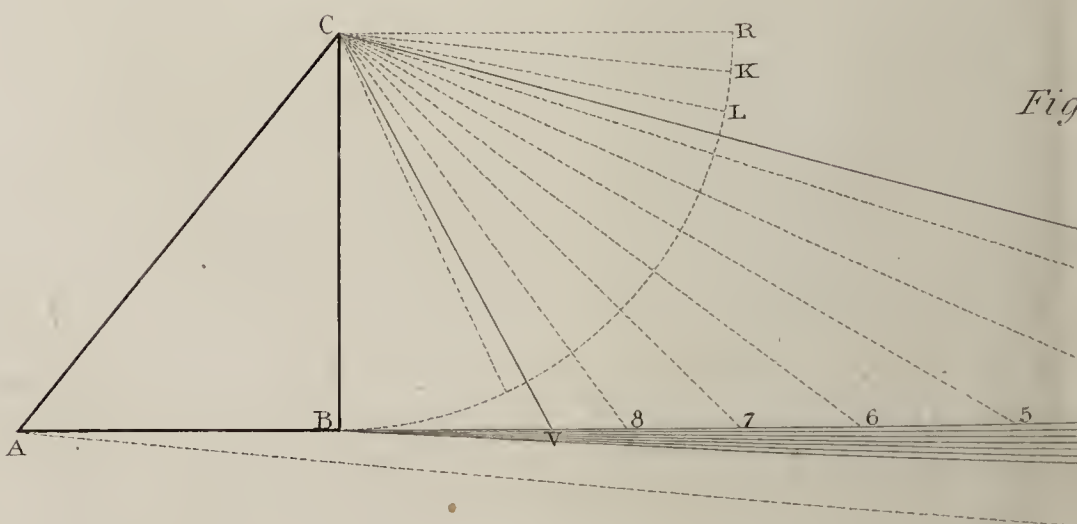




Fig

Joseph Clement, Del.

Davis's Sun Dial.

Fig. 1.

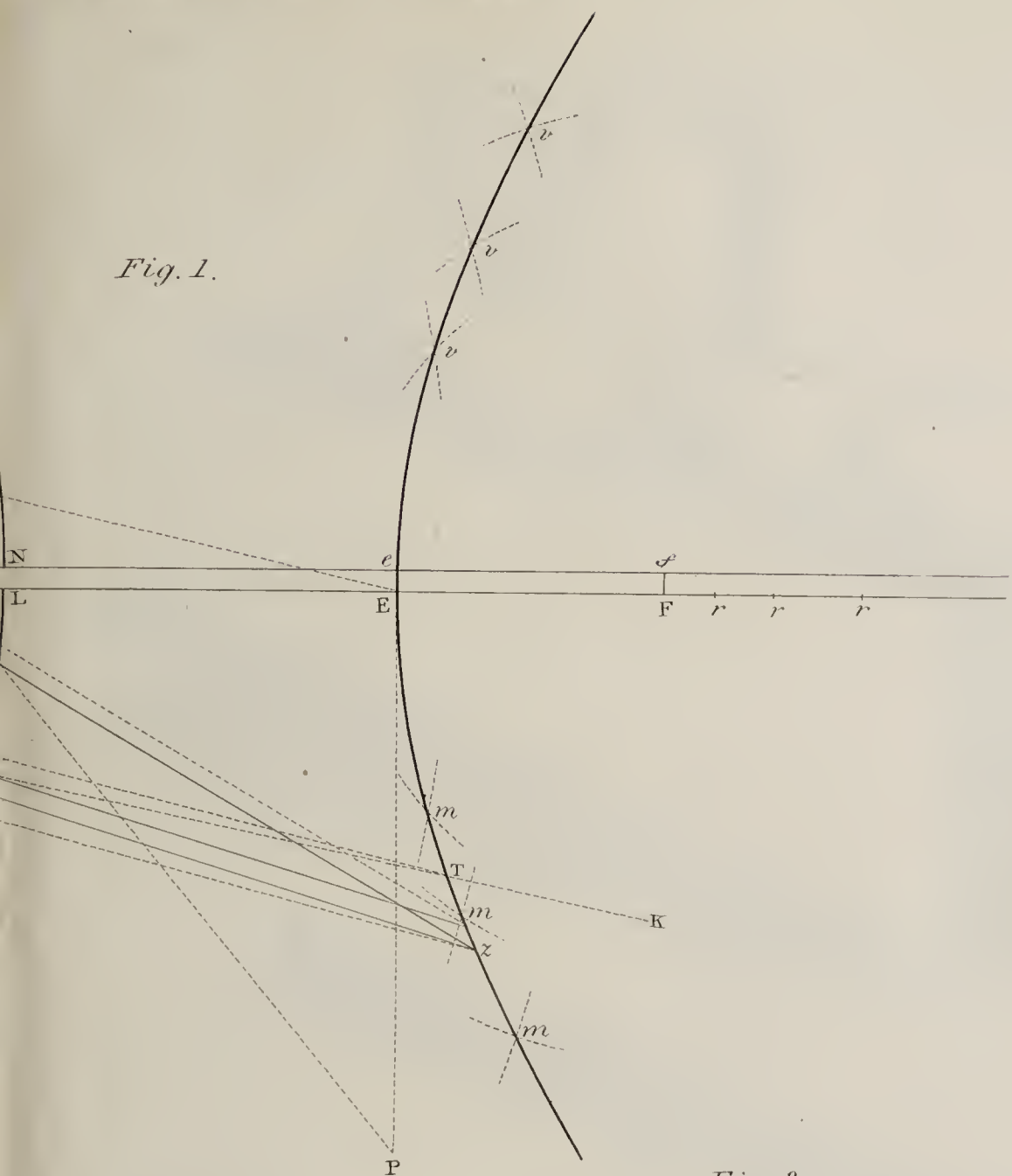
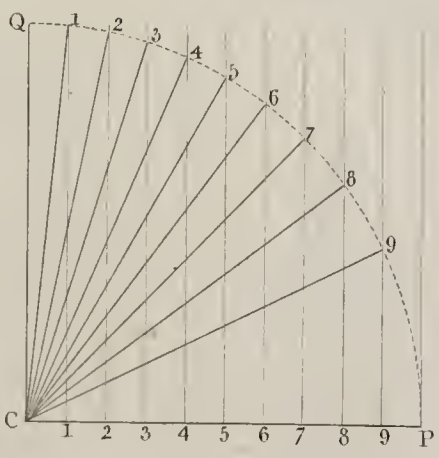
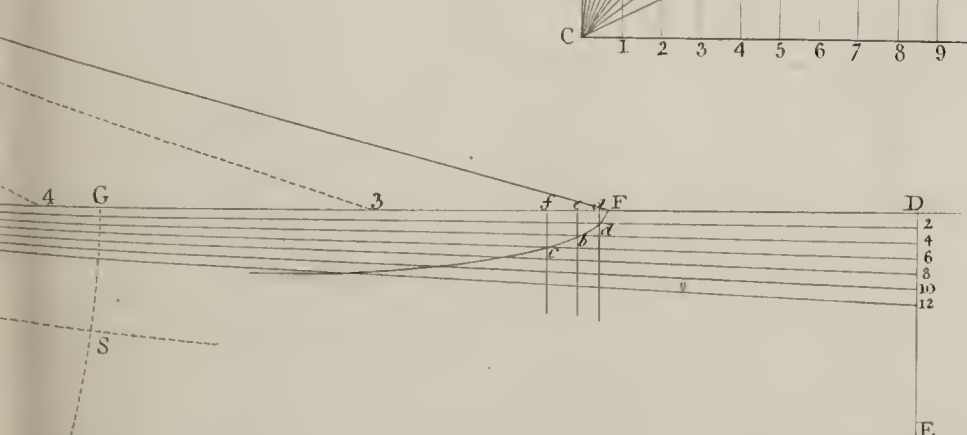


Fig. 3.

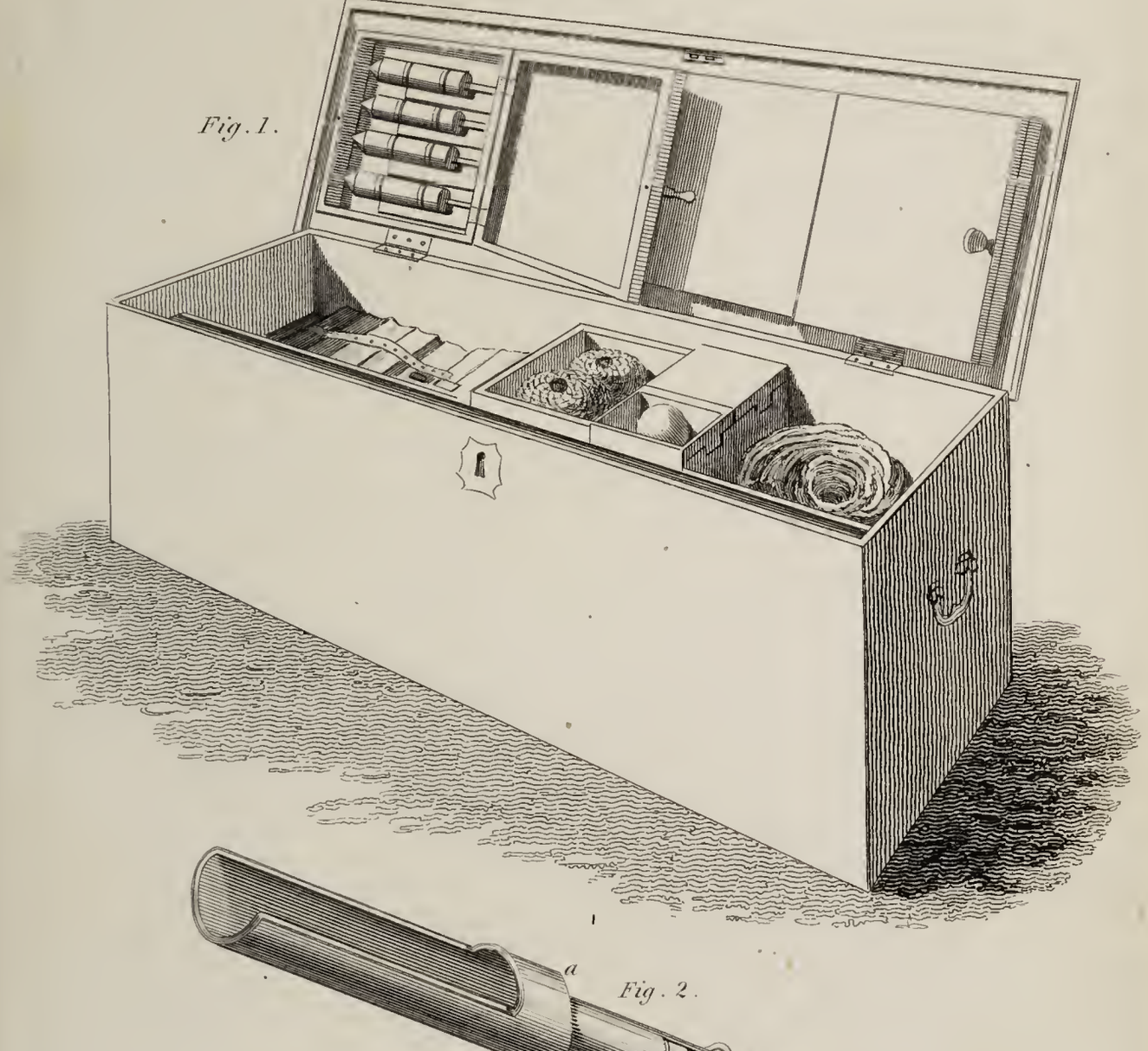




James Davis. Sculp.

Mr. H. Trengrouse's apparatus for rescuing persons from shipwreck.

Fig. 1.



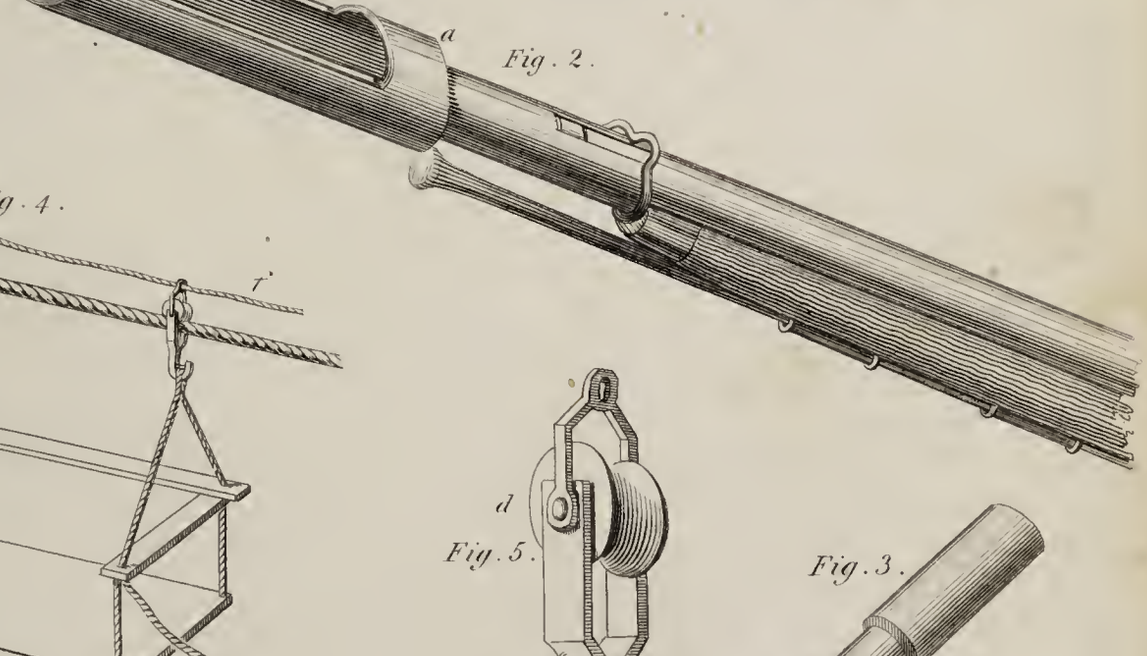
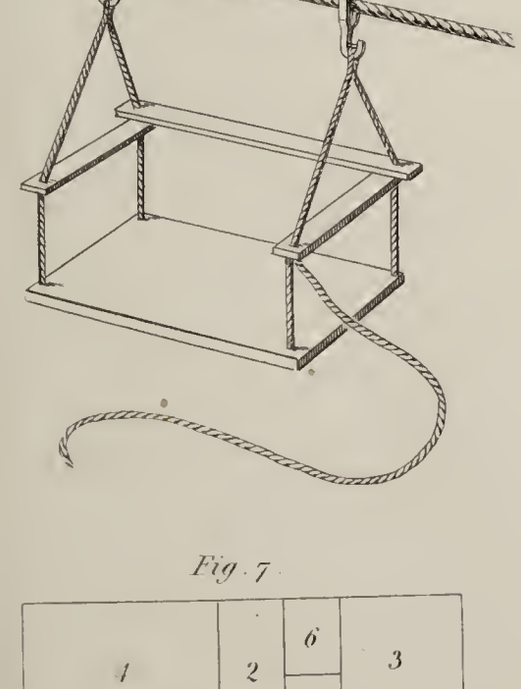


Fig. 2.

Fig. 4.



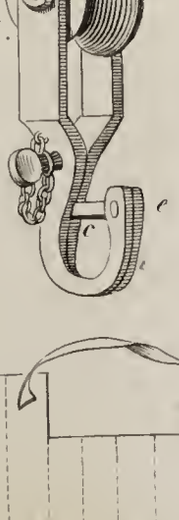
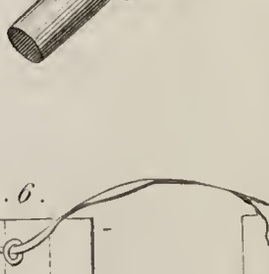


Fig. 5.

Fig. 3.



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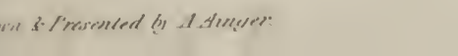

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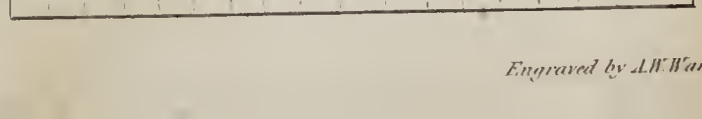
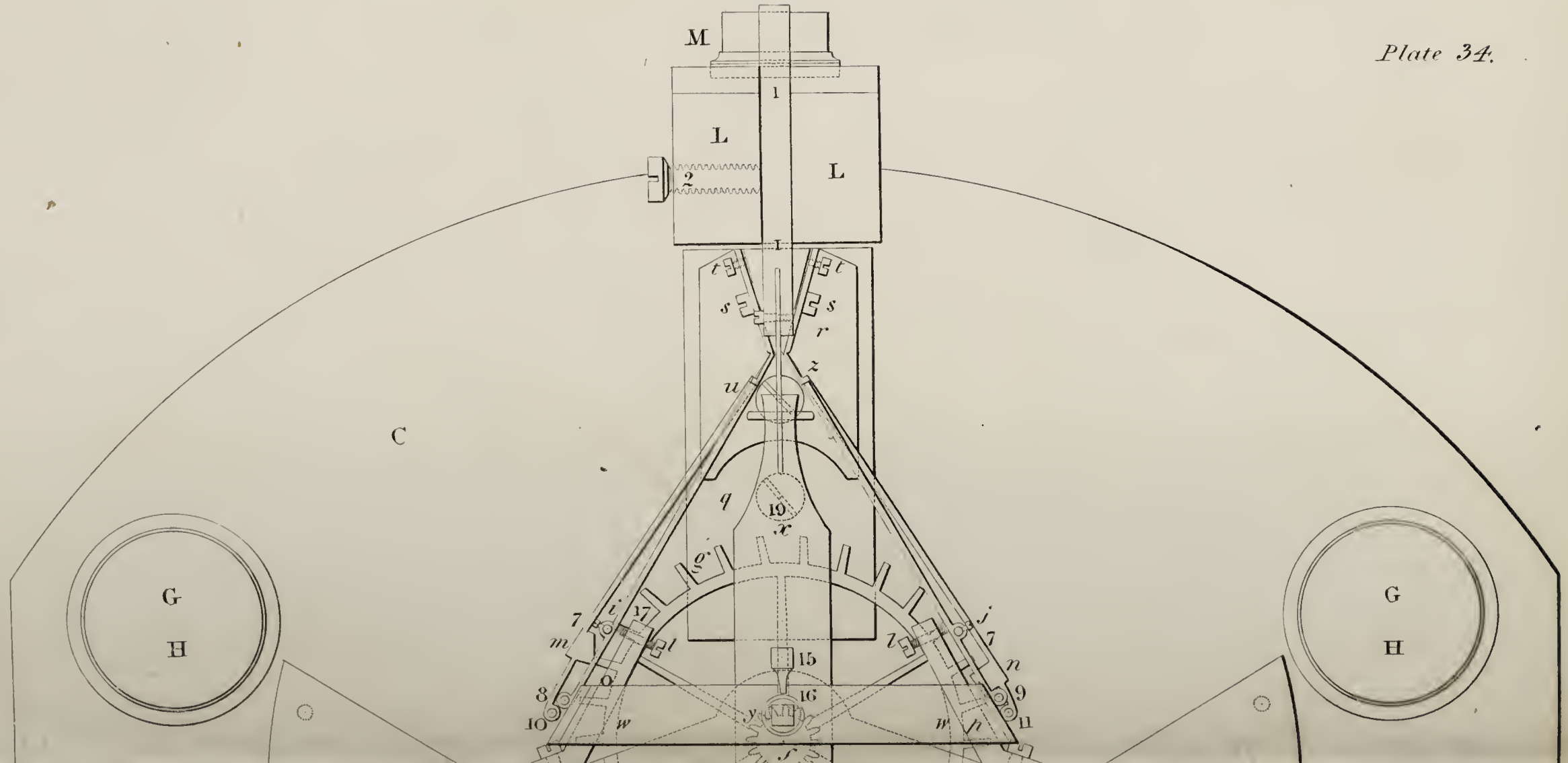


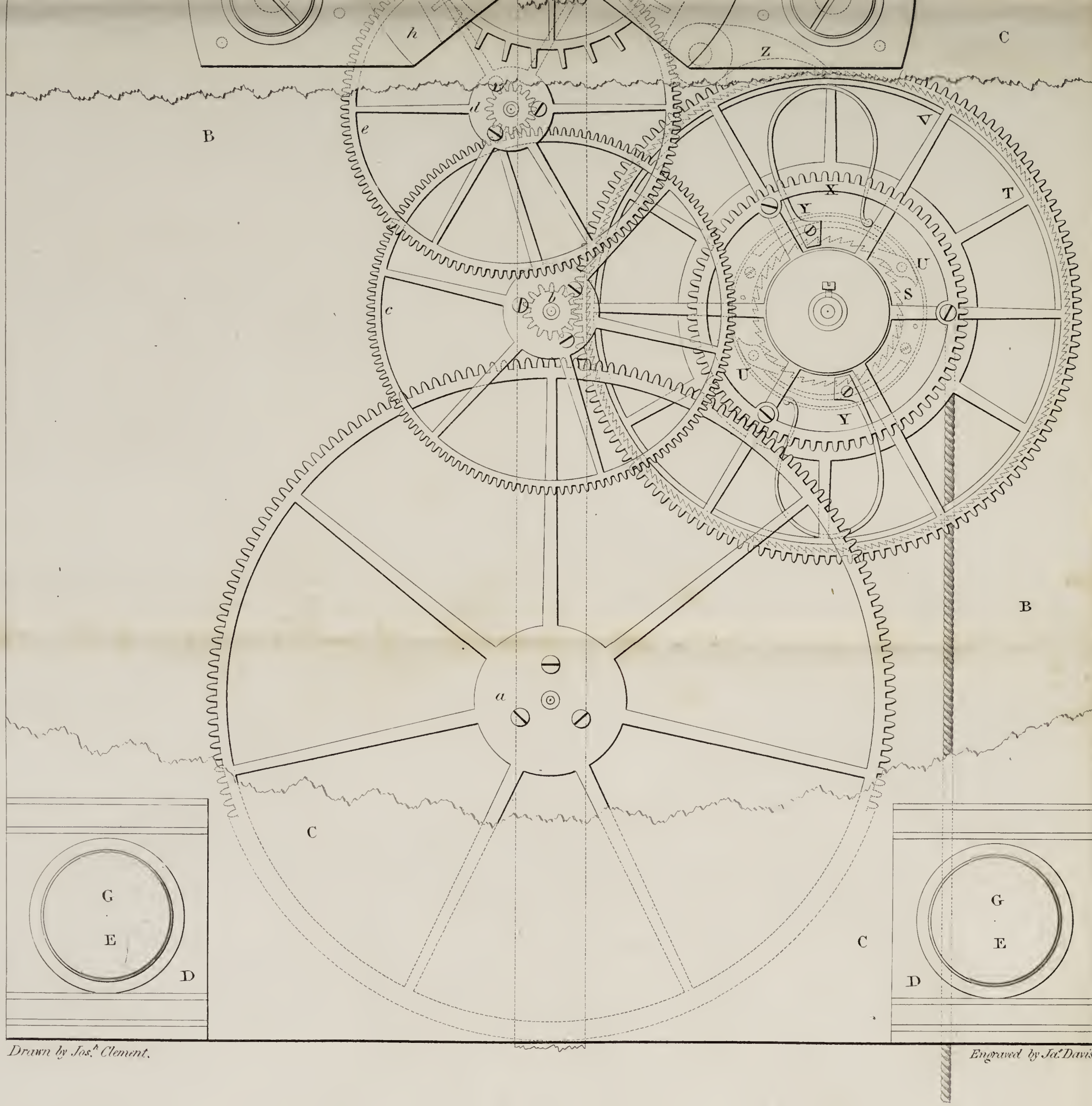
Drawn & Presented by A. Aungier.

Engraved by J.W. Warr

Mr. W. Hardy's Timekeeper.

Plate 34.



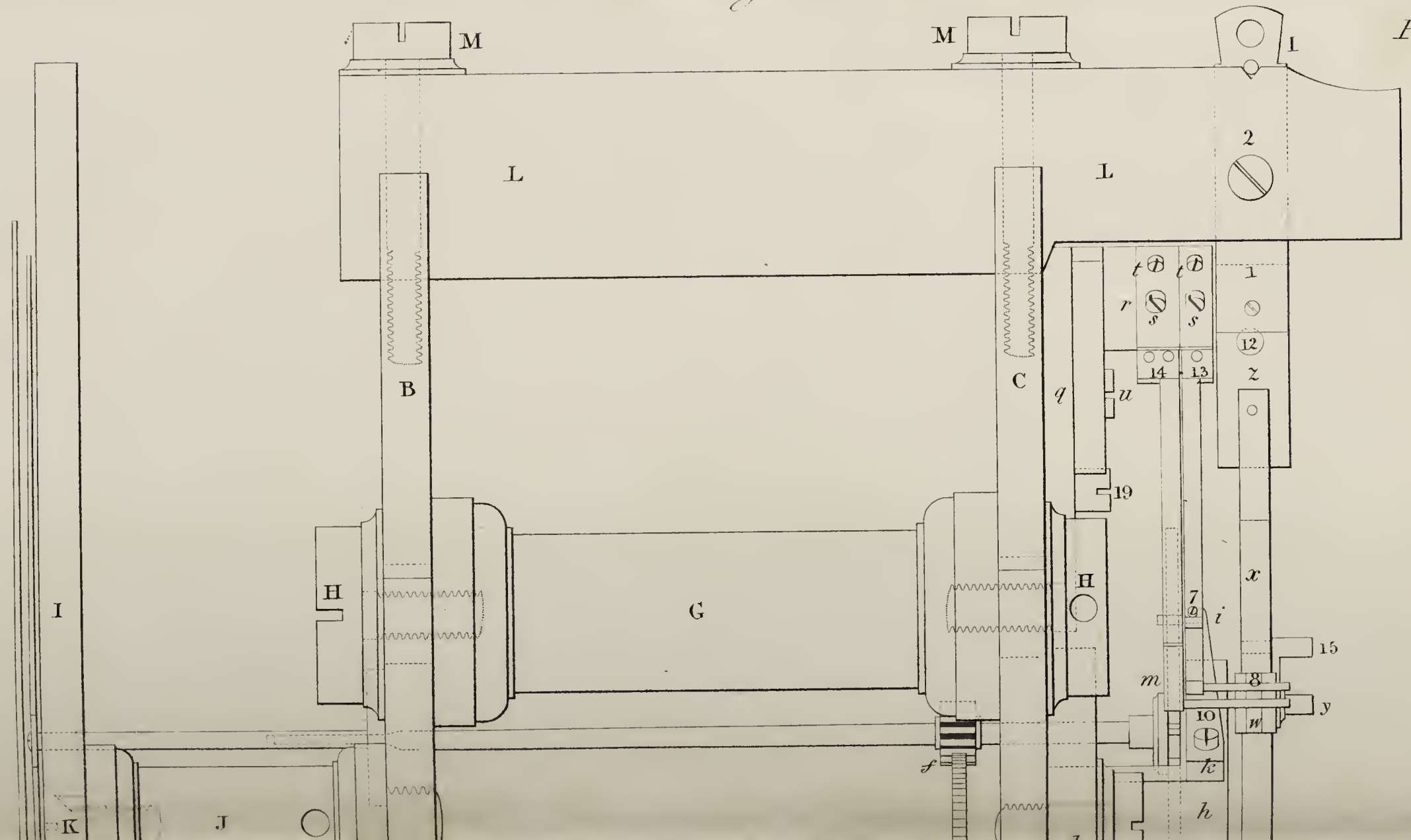


Drawn by Jos.h Clement.

Engraved by Ja.s Davis.

Mr W. Hardy's Timekeeper

Plate 35.



Engraved by Jn.º Davis.

Drawn by Jos.h Clement.

Mr. W. Hardy's Timekeeper.

Plate 36.

Fig. 12

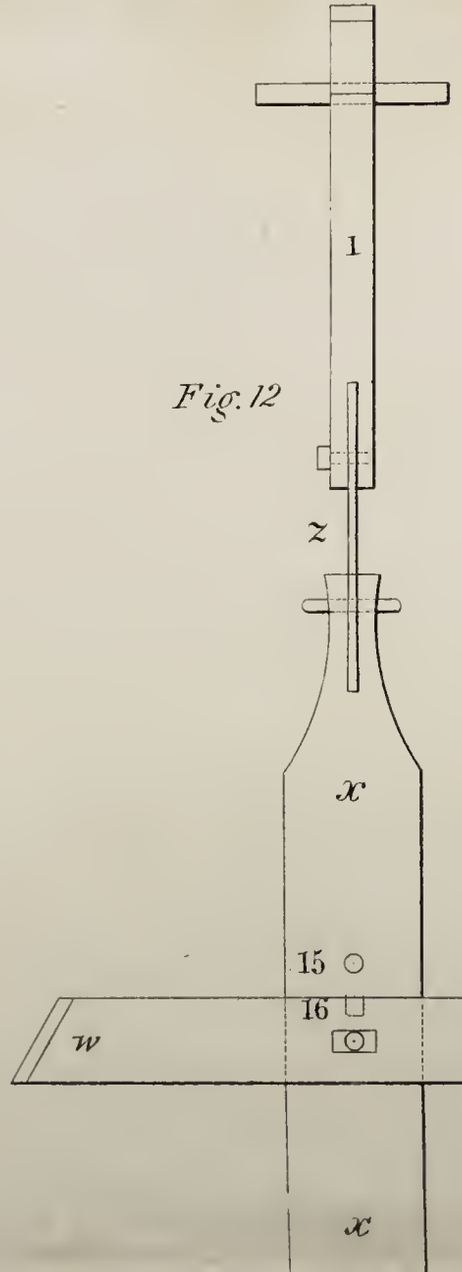


Fig. 14

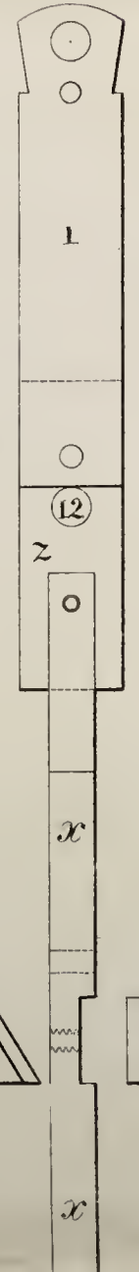


Fig. 9

Fig. 11

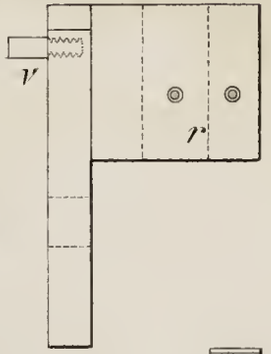
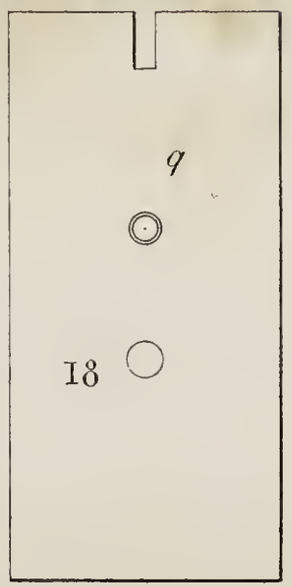


Fig. 8



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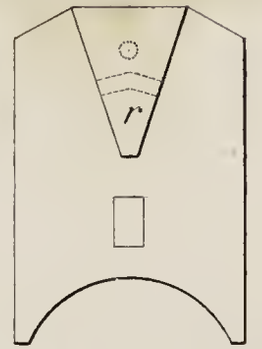


Fig. 3

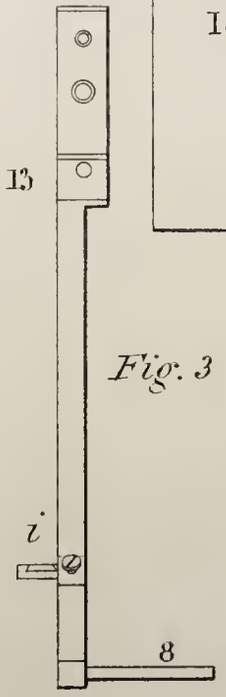


Fig 15

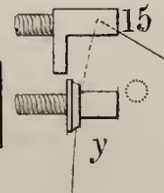


Fig. 1

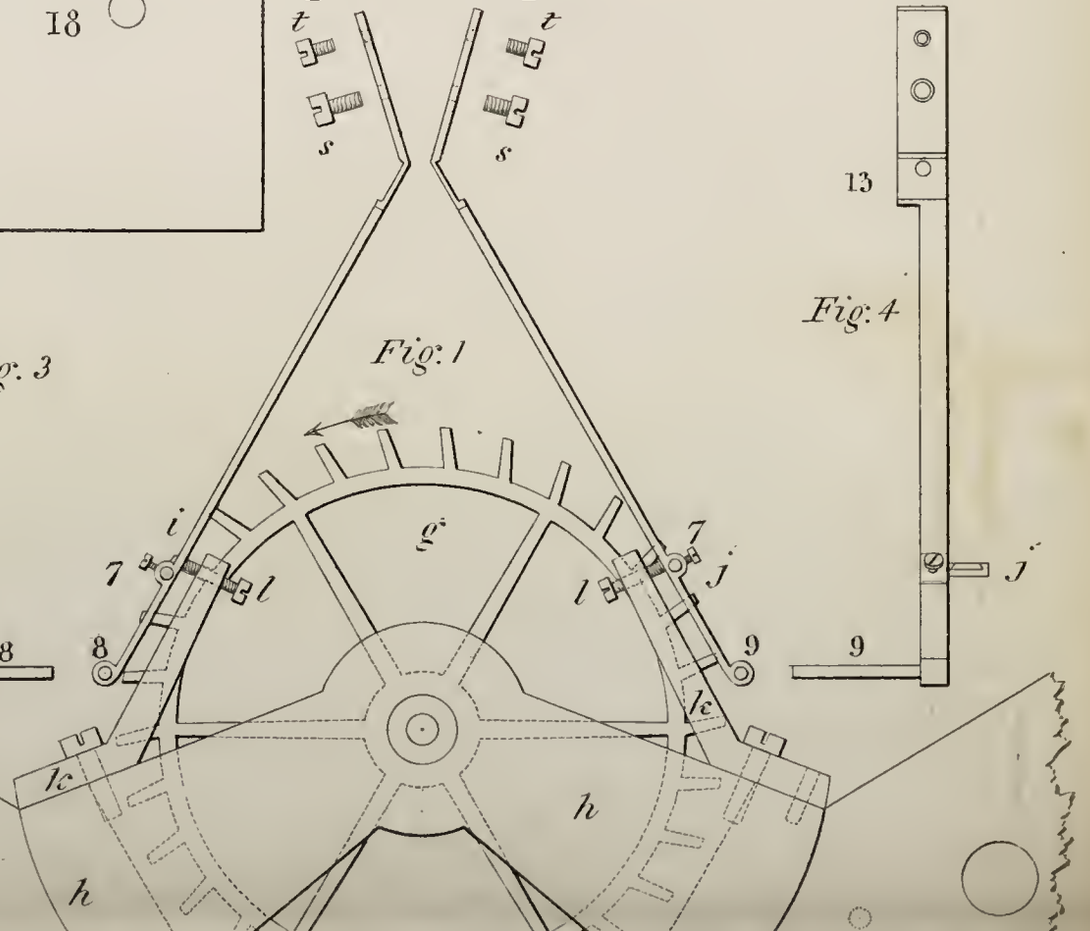
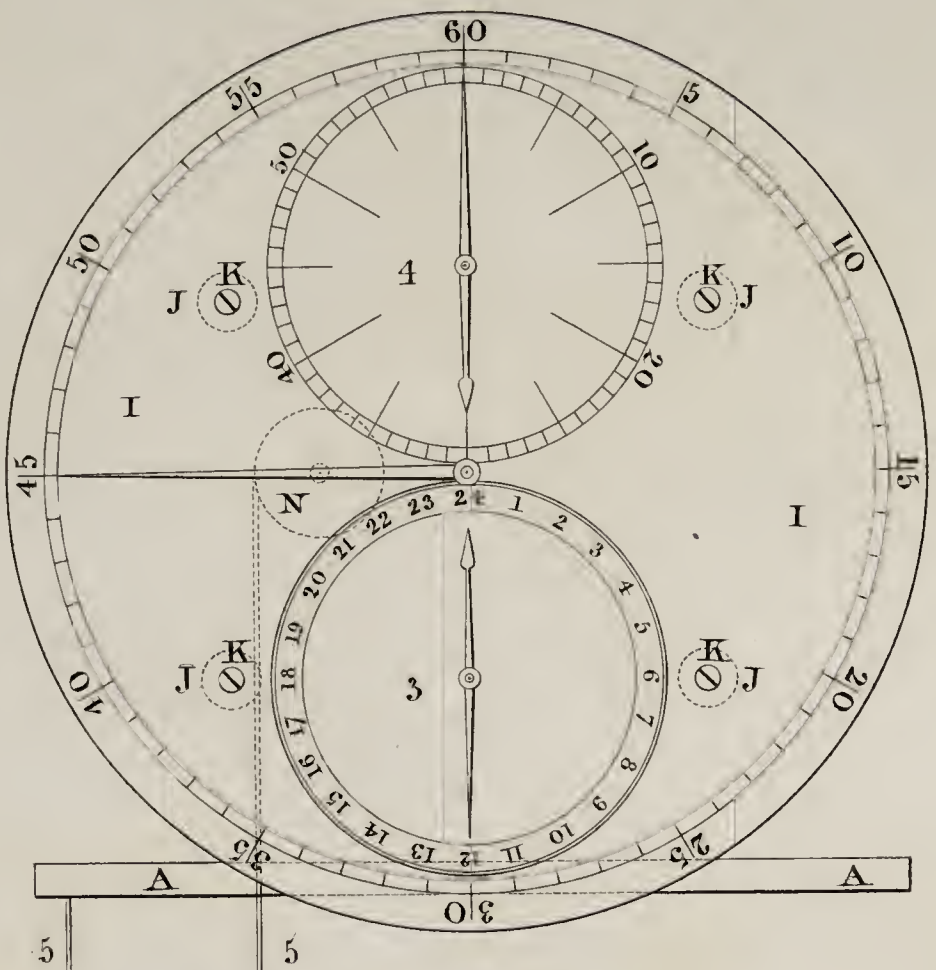


Fig. 4

Fig. 16.



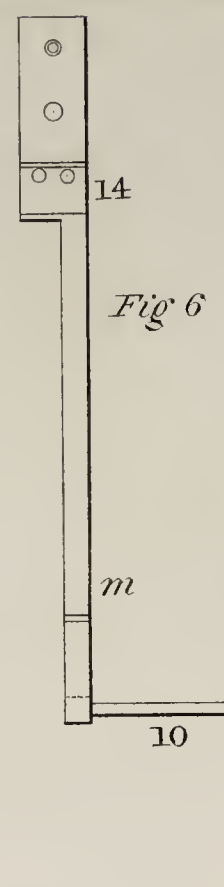


Fig 6

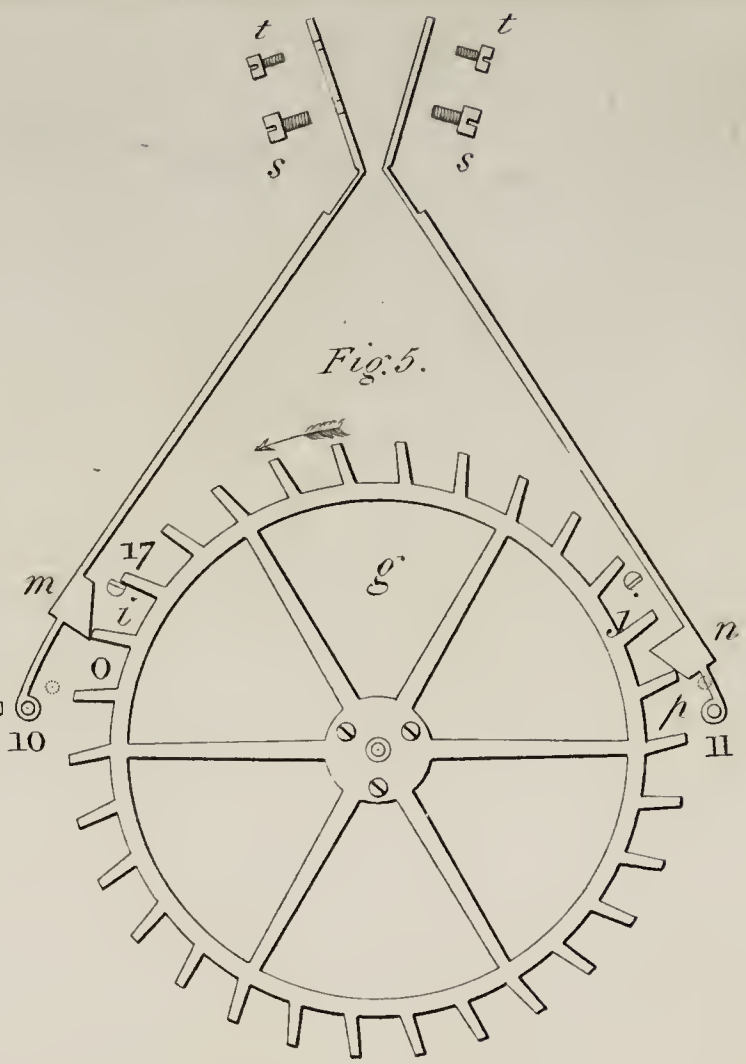


Fig. 5.

Fig. 7

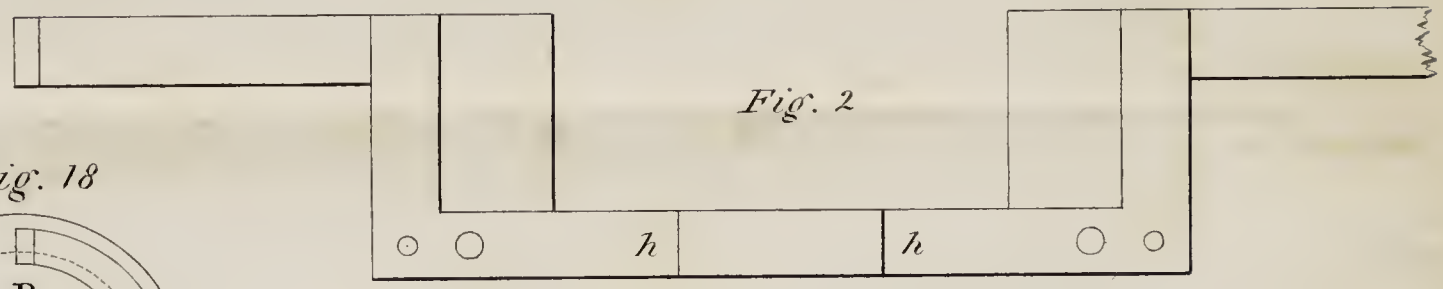


Fig. 2

Fig. 17

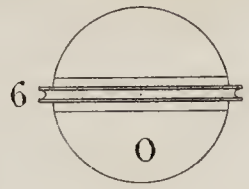
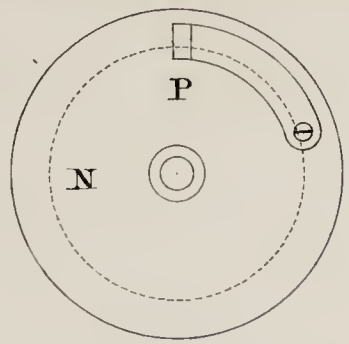


Fig. 18

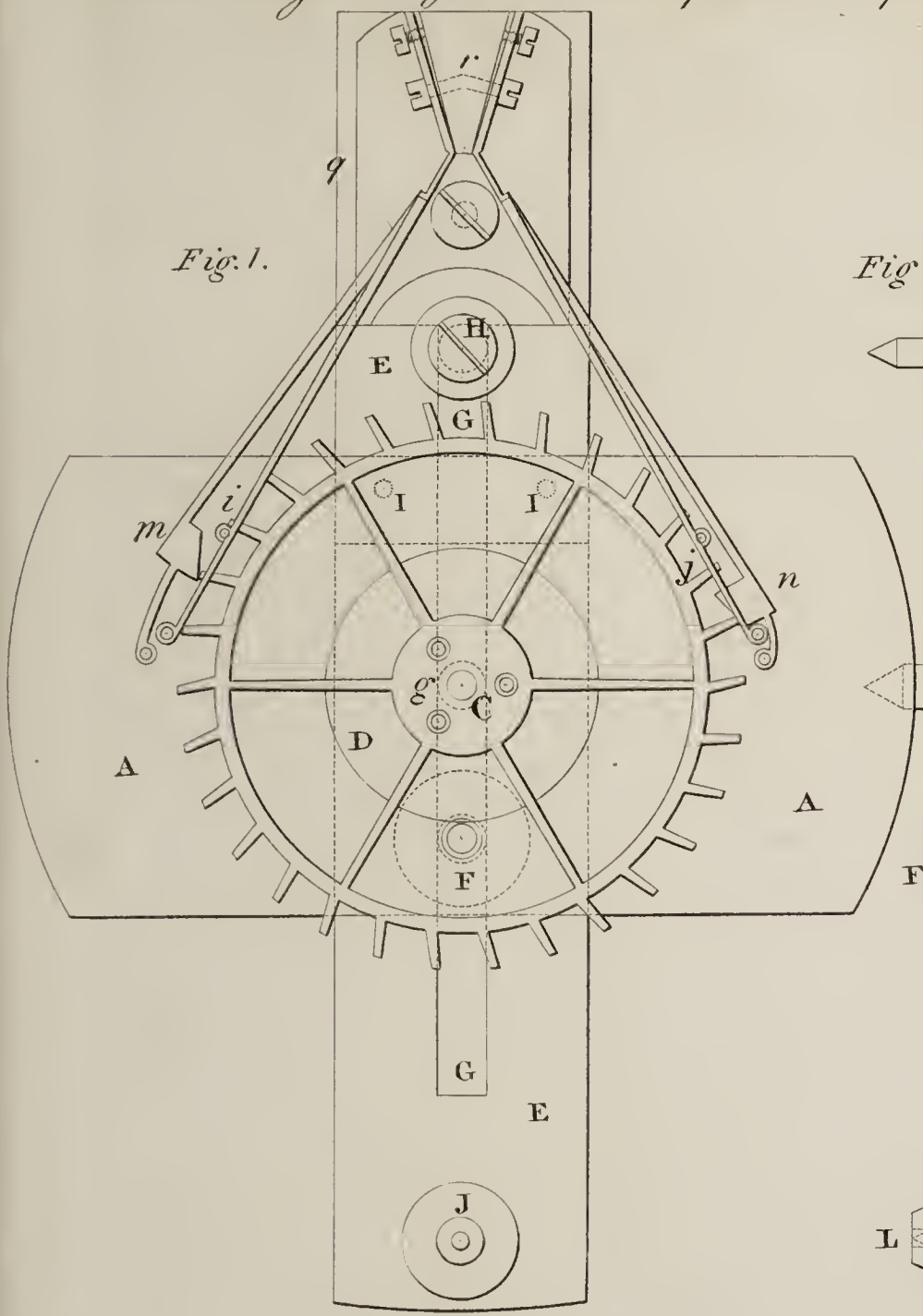


Drawn by Jos.h Clement.

Engraved by Ja.s Davis.

Mr. W. Hardy's Instruments for pitching the teeth of Wheels & adjusting the teeth of the Escapement Wheel.

Fig. 1.



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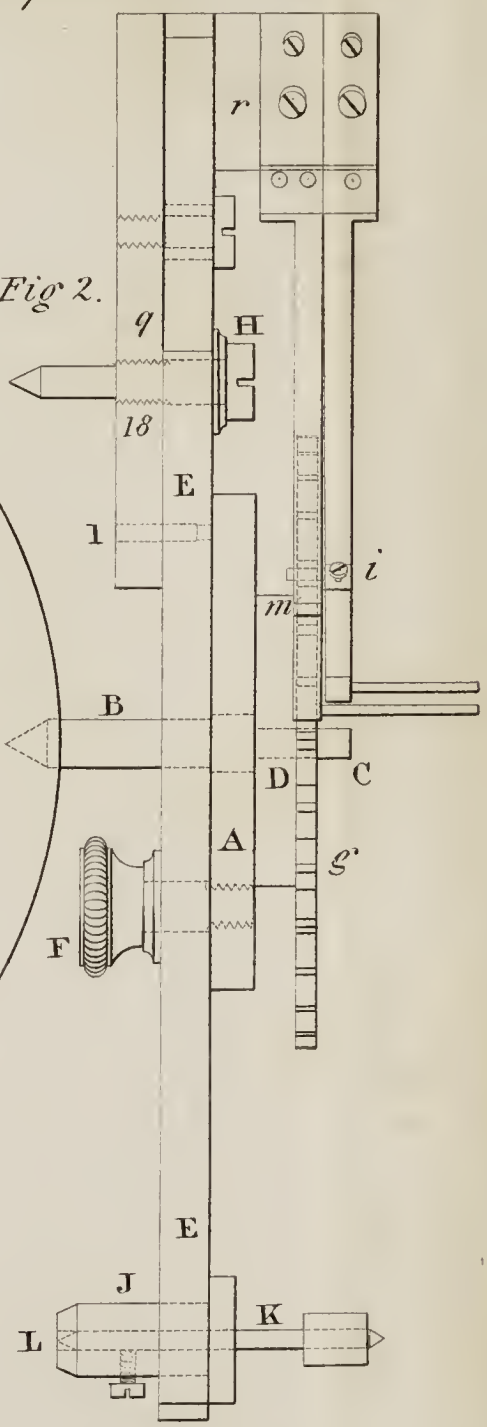

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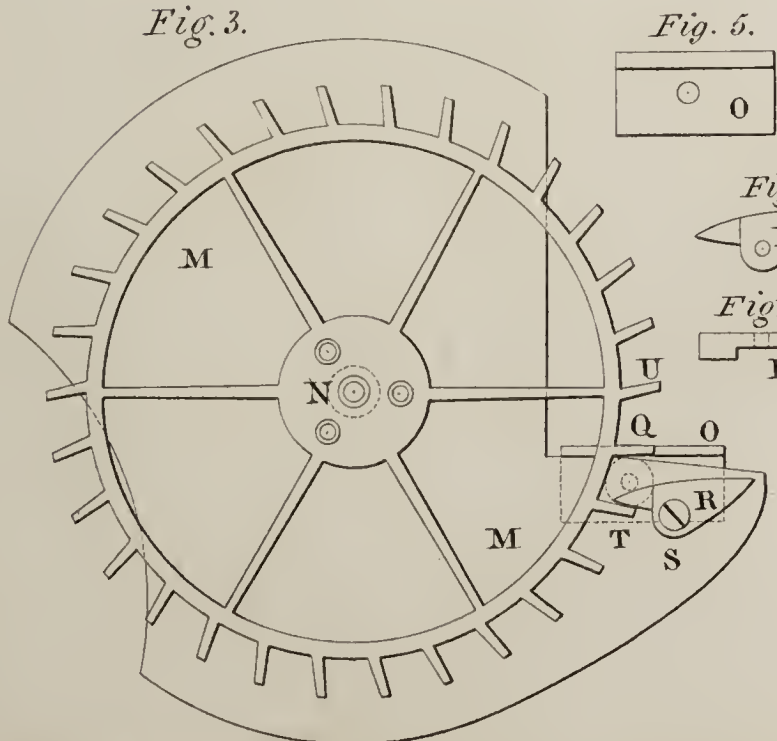


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

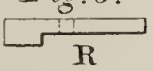
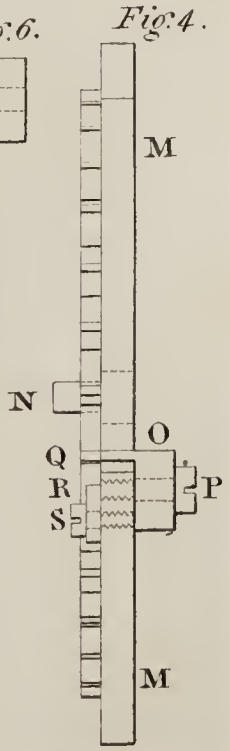


Fig. 4.



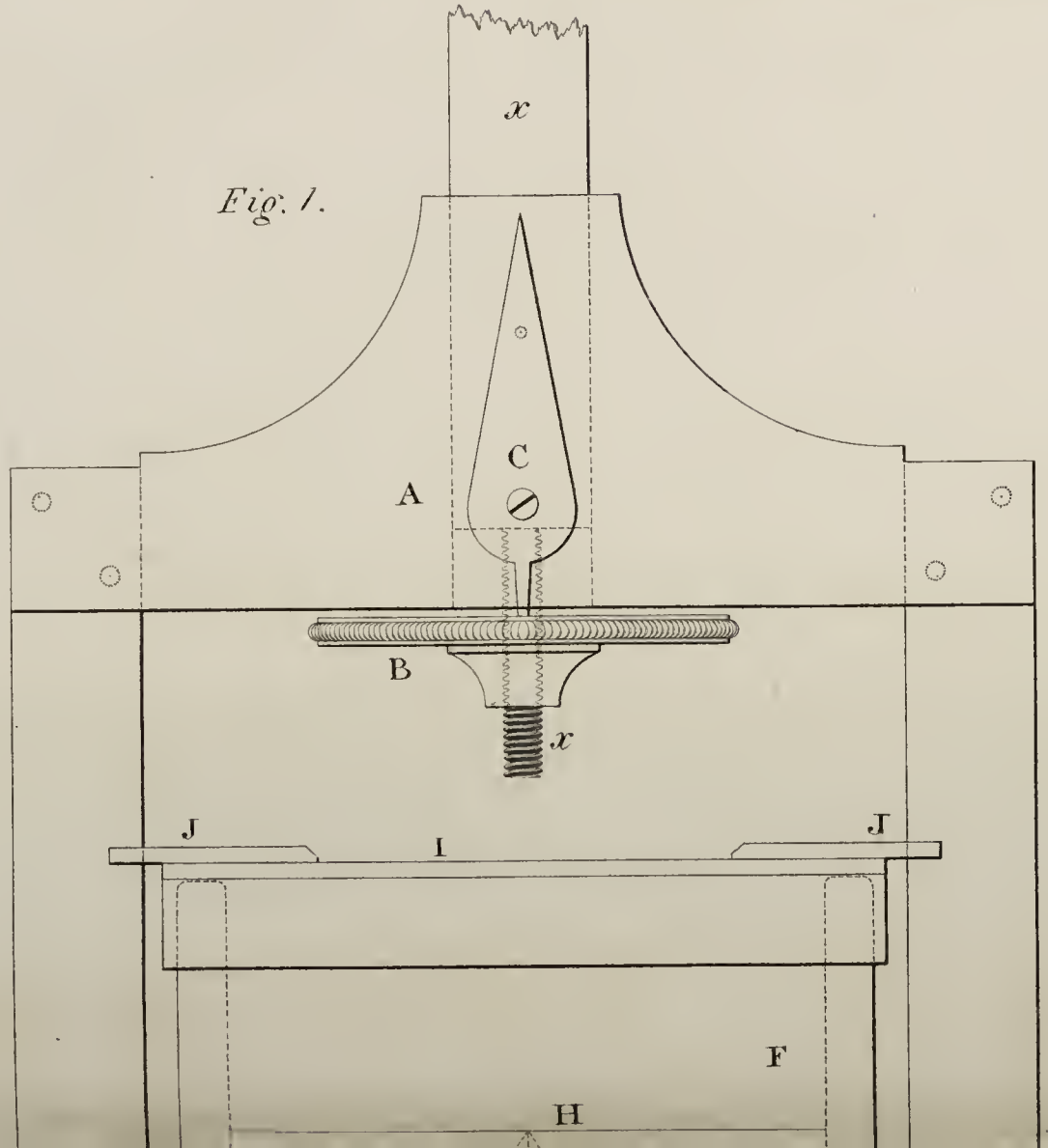
Drawn by Jos.ᵏ Clement.

Engraved by Ja.ˢ Davis.

Mr W. Hardy's Timekeeper.

Plate 38.

Fig. 1.



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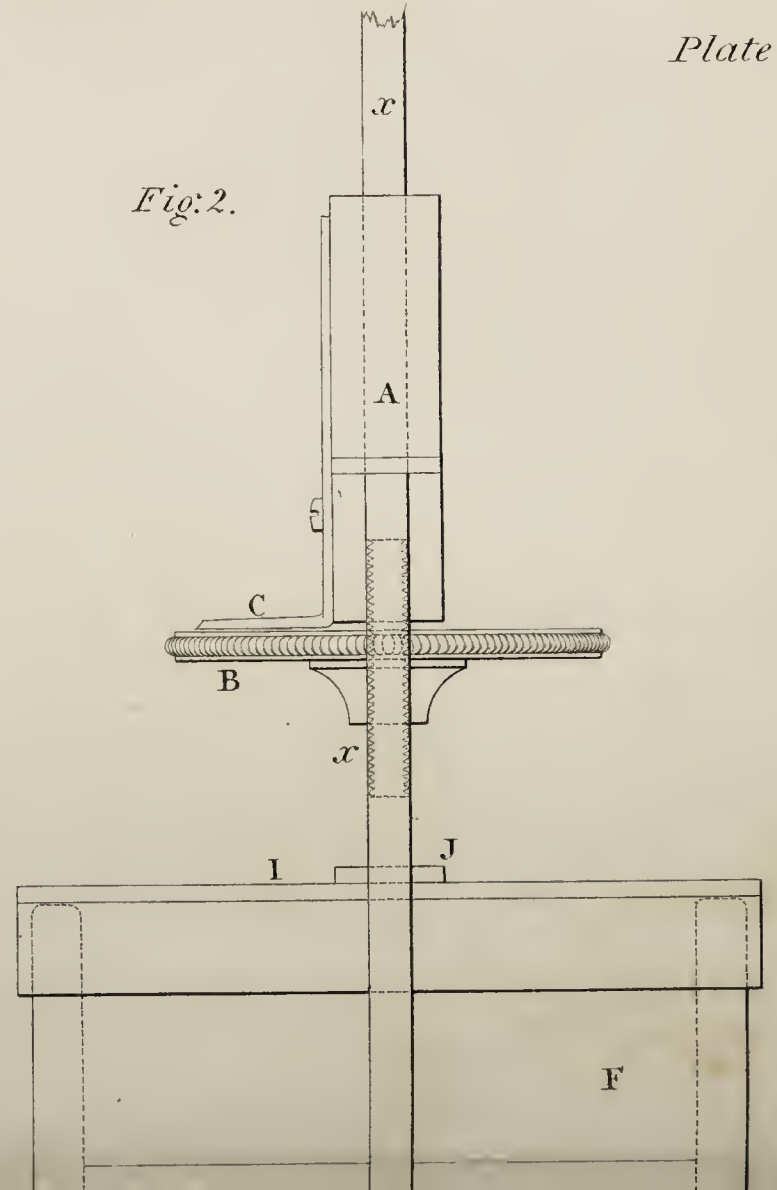

D

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F

E

K

Drawn by Jos.h Clement.

Engraved by Ja.s Davis.

A

LIST

OF

CONTRIBUTING MEMBERS

TO THE

SOCIETY

FOR THE

ENCOURAGEMENT OF

ARTS, MANUFACTURES, AND COMMERCE.

Extended to December 31st, 1820.

N. B. Those marked with * * pay Five Guineas annually; those marked with * Three Guineas annually; those with P are Perpetual Members; those with †† have served the Office of Steward; and those marked with † are Stewards Elect.

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Adams, Quinsey, Esq. *United States*
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Aldridge, John, Esq. 9, *New-square, Lincoln's Inn*
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†† Alexander, Daniel, Esq. *Blackheath*
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Allen, William, Esq. 7, *Leadenhall-street*
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Arnold, Mr. William, 21, *New-street, Spring Gardens*
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Astbury, Mr. William, 5, *Portugal-street*
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Atkinson, Thomas, Esq. *Old Swan-lane*
†† Attersol, Joseph, Esq. *Covent Garden Chambers*
Austine, Mr. George

B

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P Beverley, Algernon, Earl of, 8, *Portman-square*
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P Bridgewater, John William, Earl of, F.R.S. F.S.A. F.L.S. F.H.S. *Grosvenor-square, & Ashridge-park, Hertfordshire*
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†† Backler, Joseph, Esq. 18, *Newman-street*
†† Bacon, Anthony, Esq. *Benham-place, near Newbury, Berks*
P †† Bacon, John, Esq. F.S.A. 17, *Newman-street*
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P Bailey, Joseph, Esq. *Cyfartha, Glamorganshire*
Bailey, Mr. William, 272, *High Holborn*
Baker, Mr. Ezekiel, 24, *Whitechapel-road*
Baker, Mr. Richard
Baker, John, Esq. 10, *James-street, Westminster*
Baldwin, Robert, Esq. 6, *Queen-square, Bloomsbury*
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P Barnard, Edward, Esq. *Deptford*
Barnard, Mr. Thomas, 72, *Strand*
†† Barnardiston, Nathaniel, Esq. 8, *Charlotte-street, Bedford-sq.*
Barnes, John, Esq. 5, *Norfolk-street, Strand*
Barnet, Richard Clemson, Esq. 62, *Mortimer-street*
Barron, Mr. Francis William, 476, *Strand*

Barron, George, Esq. 11, *Beaufort-buildings, Strand*
P Barry, P. B. Esq. *Totterton, Notts*
Bartholomew, Mr. William
Barto Valle, Anthony, Esq. 21, *Haymarket*
Barton, John, Esq. *Royal Mint*
P Bate, John, Esq. 15, *Russell-square*
Bates, Thomas, Esq. 11, *South-place, Kennington*
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Bayford, John, Esq. F. S. A. *Doctors' Commons*
Bayles, Mr. James, 215, *Strand*
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Baynes, Mr. Charles, 9, *Cook's-court, Carey-street*
†† Beale, Daniel, Esq. 2, *Fitzroy square*
P Bean, Nathaniel, Esq. *Bath*
P Bean, Captain Isaac, *Ditto*
Beauchamp, Mr. William, 25, *Grafton-street, Soho*
Beaufoy, Col. Mark, F. R. S. F. L. S. *Bushy, near Stanmore*
P Beaufoy, Henry, Esq. F. R. S. F. L. S. *South Lambeth*
†† Beaumont, Daniel, Esq. 38, *Hart-st. Bloomsbury* (Chairman of the Committee of Miscellaneous Matters.)
†† Beaumont, J. T. B. Esq. F. S. A. *County Fire Office, Regent-street* (Chairman of the Committee of Polite Arts.)
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Bedington, William, Esq. *Camphill, Birmingham*
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Bell, Charles, Esq. 28, *Dean-street, Soho*
Bellamy, John, Esq. *House of Commons*
Bennett, James Samuel, Esq. *Lawrence Pountney-hill*
Bensley, Benjamin, Esq. *Nelson-square*
Benson, Arthur, Esq. 19, *Abingdon-street*
†† Benwell, Joseph, Esq. *Battersea*
P Berkley, John, Esq.
†† Bernasconi, Francis, Esq. 20, *Alfred-place*
Bernasconi, Francis, jun. Esq. 20, *Alfred-place*
Bevans, Mr. James
Bewick, William, Esq. 15, *Nassau-street, Middlesex Hospital*
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Bird, Mr. Stephen, *Kensington*
†† Bish, Thomas, Esq. 9, *Cornhill*
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Blackburn, John, Esq. *Church-yard-court, Temple*
Blackburn, John, Esq. 189, *Piccadilly*
†† Blackburne, John, Esq. M.P. F.R.S. 2, *Park-st. Westmins.*
P Blackett, John, jun. Esq. 20, *London-street, Mark-lane*
†† Blades, John, Esq. 5, *Ludgate-hill*
Blades, John, jun. Esq. *Ditto*
Blake, Mr. Charles, *New South Wales*
Blake, Mr. Henry, 10, *Rockingham-place, Kent Road*
†† Blake, Robert, Esq. 14, *Essex-street*
Blakemore, Richard, Esq. *Valendra House, near Cardiff*
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ERRATA AND CORRIGENDA TO VOL. XXXVI.

Page 29, cancel the description of fig. 4, and substitute the following:

Fig. 4, the seed barrel, having six sets of holes round its largest circumference for the delivery of the seed, each set consisting of three holes of different sizes: *s s* is a moveable hoop surrounding the barrel, and pierced by six equal holes, as large as the widest holes in the barrel. This hoop is moveable, and by means of the pin *t* may be fixed so as to leave uncovered any one of the three sets of holes in the barrel according as the seed is to be scattered more or less distant in the drills.

r a hole with a sliding cover, through which the seed is poured into the barrel.

Page 80, between the description of figs. 4 and 8 insert the following:

Fig. 6, a front view of one of the iron cheeks, shown laterally in figs. 1, 2, and 5.

Page 94, *line* 22, after C C insert *hoops*.

—— 97, — 32, after the word "supply," insert, *g* a hole opening externally for the admission of air, *i* a valve which prevents the escape of the steam, but is capable of yielding to the pressure of the external air; *k* a screwed stopper which gives access to the valve when it wants repair, &c.

Plate 9, referred to *p.* 98, the ruled shading between the squares of fig. 2 is a mistake, each square representing a different position of the same board.

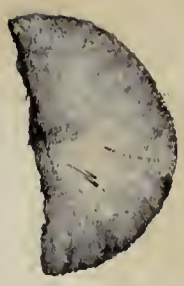
Page 102, *line* 13, for *back and front*, read *inside and outside*.

—— 111, — 1, for *right*, read *left*.

—— 150, — 29, for *on the dot*, read *on the second dot*.

N. B. It is recommended to detach this list of errata from the present Volume, and to place it in that to which it refers.

ERRATA AND CORRIGENDA IN VOL. XXXVII.

Page 87, *line* 1, for *A*, read *C*.
—— 118, — 16, for *XVIII*, read *XIX*.
— 19, for *XIX*, read *XVIII*.
— 21, for *XIX*, read *XVIII*.
—— 123 — 11, for *inner*, read *outer*.
— 14, for *outer*, read *inner*.
— 18, for *XIX*, read *XVIII*.
— 19, for *XVIII*, read *XIX*.
—— 155, — 24, for *o*, read *O*.
—— 177, — 12 and 17, for *p*, read *q*.
—— 180, — 5 and 14, for *s*, read *f*.
— 16, for *V V*, read *v v*.

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